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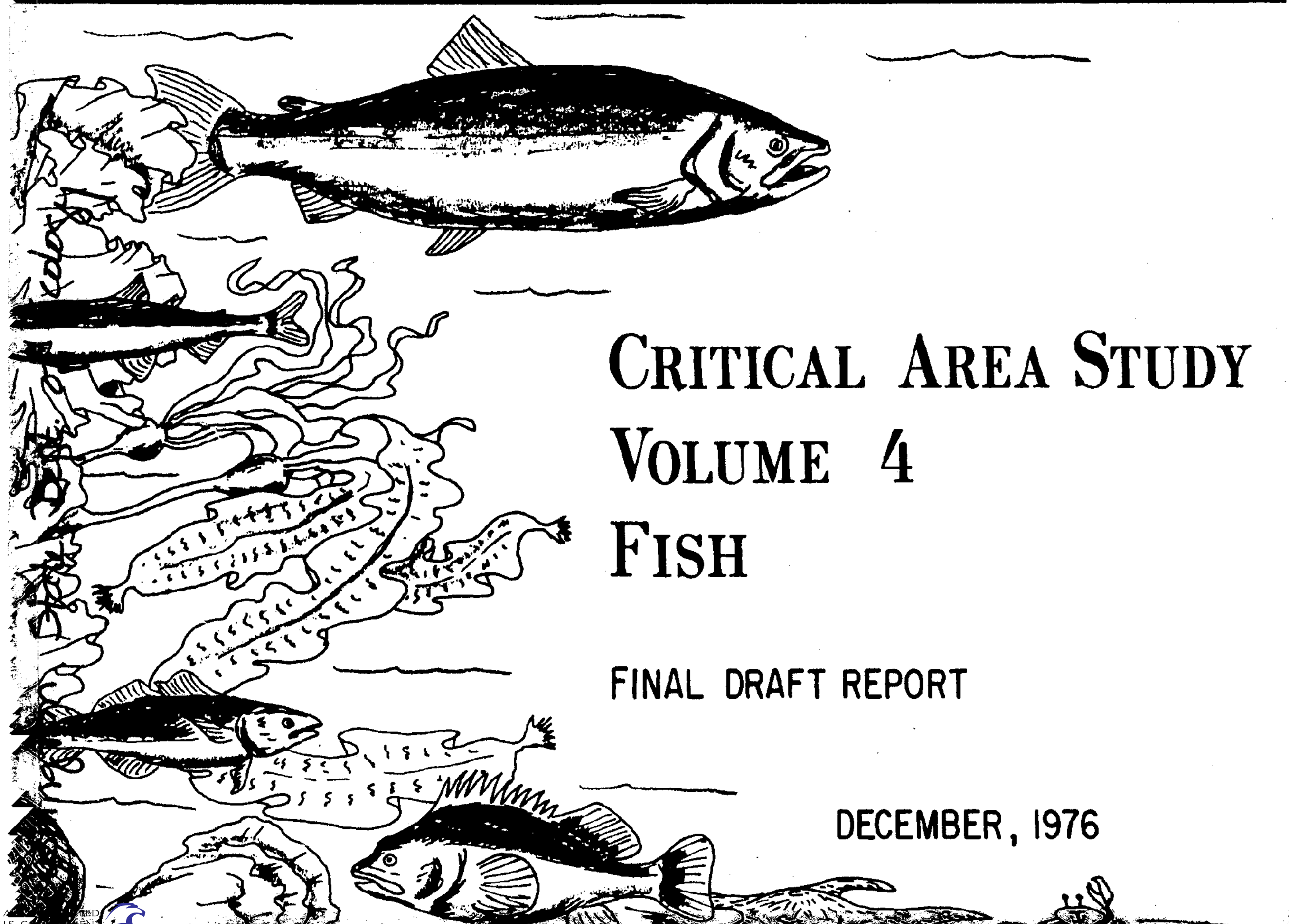
State of Washington Department of Ecology

BASELINE STUDY PROGRAM



CRITICAL AREA STUDY
VOLUME 4
FISH

FINAL DRAFT REPORT

DECEMBER, 1976

10542

W.P.

CRITICAL AREA STUDY

VOLUME IV

FISH

By

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Washington. State. Dept. of Ecology

INDEX TO FISH SPECIES

CODE NO.	COMMON NAME
F-1	Sablefish (Blackcod)
F-2	Lingcod
F-3	Pacific Sanddab
F-4	Arrowtooth Flounder
F-5	Petrale Sole
F-6	Rex Sole
F-7	Pacific Halibut
F-8	Butter Sole
F-9	Rock Sole
F-10	Dove Sole
F-11	English Sole
F-12	Starry Flounder
F-13	C-O Sole
F-14	Curlfin Sole
F-15	Sand Sole
F-16	Flathead Sole
F-17	Slender Sole
F-18	Plainfin Midshipman
F-19	Pacific Cod
F-20	Pacific Hake
F-21	Pacific Tomcod
F-22	Walleye Pollock
F-23	Wolf-Eel
F-24	Pacific Ocean Perch
F-25	Silvergray Rockfish (Short-Spine)
F-26	Copper Rockfish
F-27	Puget Sound Rockfish
F-28	Yellowtail Rockfish
F-29	Black Rockfish

CODE NO.	COMMON NAME
F-30	Bocaccio
F-31	Yelloweye Rockfish
F-32	Canary Rockfish (Orange)
F-33	Chilipepper
F-34	Redbanded Rockfish (Flag)
F-35	Rougheye Rockfish
F-36	Splitnose Rockfish
F-37	Greenstriped Rockfish
F-38	Brown Rockfish
F-39	Redstripe Rockfish
F-40	Big Skate
F-41	Longnose Skate
F-42	Ratfish
F-43	White Sturgeon
F-44	Green Sturgeon
F-45	Cutthroat Trout (Coastal)
F-46	Kelp Greenling
F-47	Rock Greenling
F-48	Whitespotted Greenling
F-49	Buffalo Sculpin
F-50	Red Irish Lord
F-51	Pacific Staghorn Sculpin
F-52	Tidepool Sculpin
F-53	Cabezon
F-54	Redtail Surfperch
F-55	Kelp Perch
F-56	Shiner Perch
F-57	Striped Seaperch
F-58	Walleye Surfperch
F-59	Pile Perch

CODE NO.	COMMON NAME
F-60	White Seaperch
F-61	Penpoint Gunnel
F-62	Saddleback Gunnel
F-63	Crescent Gunnel
F-64	Quillback Rockfish
F-65	American Shad
F-66	Pacific Herring
F-67	Northern Anchovy
F-68	Chinook Salmon (King)
F-69	Coho Salmon (Silver)
F-70	Pink Salmon (Humpy)
F-71	Sockeye Salmon (Red)
F-72	Chum Salmon (Dog)
F-73	Masu Salmon (Cherry)
F-74	Rainbow Trout (Steelhead)
F-75	Surf Smelt
F-76	Longfin Smelt
F-77	Eulachon
F-78	Capelin
F-79	White Seabass
F-80	Pacific Sand Lance
F-81	Spiny Dogfish

INTERPRETATION OF FISH FACT SHEETS

Each fact sheet is headed with the accepted common and scientific names of the fish species. These names follow the American Fisheries Society, 1970, A List of Common and Scientific Names of Fishes. Special Publication No. 6, Third Edition, with one exception, the Masu Salmon (Cherry) (F-73), which is not in the AFS list. In some cases, an additional common name is included (in parenthesis).

These fact sheets and associated maps (if critical areas were determined for a species) are a preliminary evaluation of presently available information, and by no means should be construed as a final statement on these fish species.

Life History

An overview of the fish species life history in Washington is presented. This proved difficult for most of the fish species, as no one has summarized their Washington life histories as WDG did previously for mammals and birds. The closest reference for fish was the Canadian reference - (166) Hart, J. L., 1973, Pacific Fishes of Canada, Fisheries Research Board of Canada, Bulletin 180. This source provided the bulk of the life history information for most species (which were covered by this reference). This was supplemented with Washington and some Oregon and California information, primarily from a literature review - Beak Consultants, Inc., 1975, Oil Pollution and the Significant Biological Resources of Puget Sound. These literature review references are numbered in the text and are listed at the end of this volume by author and date. Volume II of the review contains the complete reference.

In addition, references were also selected with more recent information. In some cases this included older sources of information not located in the literature review. These sources have a letter reference in the text and are listed at the end of this volume.

Washington Distribution

The distribution of the fish species is briefly described for the marine and estuarine waters of Washington State to provide the reader a general understanding of the species and numbers of animals in recorded locations. Seasonal use of areas by fish is described when suitable information was located. This information will assist in determining when and where a given species would be most affected by man's activities. Unfortunately, fish distribution is not as easily observed and therefore described as for mammals and birds. Information is often semiquantitative and presented in a wide variety of units.

Habitat Requirements

A brief description of the marine and estuarine habitats utilized by the fish species is provided. These were defined using Department of Ecology habitat types (rock, sand, mud, mixed: coarse, mixed: fine, eelgrass bed, kelp bed, saltmarsh, and open water) where possible. As the literature allowed, more specific details were added to better define the habitat used.

The fish habitat used is summarized in Table 1.

Critical Habitat Areas

The major thrust of this study was to locate and define any specific critical habitat areas that may exist in Washington marine and estuarine waters for each fish species. As defined by DOE, critical habitats are:

1. The area supports population of a specie(s) that not only consistently reproduces itself but because of favorable environmental conditions (currents, water temperature, salinity, etc.) provides the major source of recruitment for adjacent areas or regions whose populations do not consistently reproduce themselves.

2. The area consists of a habitat type or types that provide either shelter, food, or other environmental necessities during a critical part of a species life history. For example: nesting sites or shelter from predators during early life history stages.

Unfortunately, our knowledge of fishes does not allow the use of the first definition; but critical habitat areas were defined for several species on the basis of the second definition.

Areas for species with critical locations were then named and underlined in the fact sheet text. Associated maps for fish illustrate these areas on overlays of USC and GS charts. On the map overlays, these areas are coded: $\boxed{\text{F-7}}$, (i.e., critical areas for fish species, F-7, Pacific Halibut).

One very important point should be remembered by the user of this material. The critical habitat areas noted are by no means to be interpreted as the only critical fish habitats in the marine environs of Washington. This is a very tentative listing based on a limited amount of data and the subjective judgment of some biologists who have studied these species and areas. As will be obvious to the reader, in many cases the areas are described in very general terms because of the lack of specific information on habitat types in an area and the usage of specific areas by the species involved.

Data Gaps

In this fact sheet section, data gaps for fish were noted that were apparent from the compilation of information for each fish species. General comments follow on how these data gaps might be filled. In some cases, where fish appeared to be incidental species in Washington waters, a comment is made questioning the validity of the species on an "important" marine and estuarine fish list for Washington State.

Fish data gaps are summarized in Table 2.

Data gaps were numerous for the fish species surveyed. Life history information for many species is supplemented from areas other than Washington which may be in error as to the timing of activities in Washington.

Distributional information is summarized for inside waters, using historic catch record summaries. The western Strait of Juan de Fuca and coast and coastal bay catch records should be similarly summarized and mapped. This historic information should provide the foundation for any further fish species surveys in Washington. The temporal distribution for many of these fish species is also a data gap. We basically need to know a lot more about where these fish species are in general and specific areas of Washington's waters.

The habitat requirements of these fish species in Washington are not well understood, however, studies such as ongoing by the University of Washington in North Sound (DOE supported), and by the University of Washington in the Strait of Juan de Fuca (NOAA-MESA supported), should be expanded with time to all waters of Washington. Once habitat requirements and distributional information are better understood for most of these fish species, more critical habitat areas may become apparent in Washington waters.

References

The study relied principally on the Beak literature review conducted for DOE. Numbered references in the fact sheet text are listed by author(s) and date at the end of the marine mammal volume and are coded with the same reference number as in Volume II of the DOE literature review.

Lettered references in the fact sheet text are for additional sources used to fill in literature review data gaps. These are listed at the end of the volume. This literature search was not exhaustive with the limited time and effort allotted for this study.

TABLE 1

FISH

		WASHINGTON HABITAT TYPES								
Species Number	Species Name	Open Water	Rock	Sand	Mud	Mixed Coarse	Mixed Fine	Eel Grass	Kelp Bed	Man-made Structures
F-1	Sablefish (Blackcod)	x		x						
F-2	Lingcod	x	x					x	x	
F-3	Pacific Sanddab			x	x		x			
F-4	Arrowtooth Flounder	x		x	x		x			
F-5	Petrale Sole	x		x			x			
F-6	Rex Sole	x		x			x			
F-7	Pacific Halibut	x		x			x			
F-8	Butter Sole	x		x						
F-9	Rock Sole	x		x		x	x	x		
F-10	Dover Sole	x		x	x					
F-11	English Sole	x		x				x		
F-12	Starry Flounder	x		x	x		x	x		
F-13	C-O Sole	x		x						
F-14	Curlfin Sole	x		x			x			
F-15	Sand Sole	x		x			x	x		

TABLE 1 (CONTINUED

FISH

Species Number	Species Name	Open Water	Rock	Sand	Mud	Mixed Coarse	Mixed Fine	Eel Grass	Kelp Bed	Man-made Structures
		WASHINGTON HABITAT TYPES								
F-16	Flathead Sole	x		x	x		x			
F-17	Slender Sole	x		x			x	x		
F-18	Plainfin Midshipman	x		x	x	x	x	x		
F-19	Pacific Cod	x		x		x	x	x		
F-20	Pacific Hake	x		x			x	x		
F-21	Pacific Tomcod	x	x	x			x	x		
F-22	Walleye Pollock	x		x		x	x	x		
F-23	Wolf-eel	x	x			x				
F-24	Pacific Ocean Perch	x	x?			x?				
F-25	Silvergray Rockfish (Short-spine)	x	x?			x?				
F-26	Copper Rockfish	x	x	x		x	x	x	x	x
F-27	Puget Sound Rockfish	x	x			x			x	
F-28	Yellowtail Rockfish	x				x				
F-29	Black Rockfish	x	x			x	x		x	
F-30	Bocaccio	x	x?			x?				

TABLE 1 (CONTINUED)

FISH

Species Number	Species Name	WASHINGTON HABITAT TYPES Open Water	Rock	Sand	Mud	Mixed Coarse	Mixed Fine	Eel Grass	Kelp Bed	Man-made Structures
F-31	Yelloweye Rockfish (Red Snapper)	x	x							
F-32	Canary Rockfish (Orange)	x	x			x				
F-33	Chilipepper Rockfish	x								
F-34	Redbanded Rockfish (Flag)	x	x?							
F-35	Rougheye Rockfish	x	x?			x?				
F-36	Splitnose Rockfish	x	x?			x?				
F-37	Greenstripe Rockfish	x	x?			x?	x			
F-38	Brown Rockfish		x				x			
F-39	Redstripe Rockfish	x	x?	x?		x?	x?			
F-40	Big Skate	x		x	x			x		
F-41	Longnose Skate	x		x	x					
F-42	Ratfish	x	x	x		x	x			
F-43	White Sturgeon	A		x	x					
F-44	Green Sturgeon	A		x?	x					
F-45	Cutthroat Trout (Coastal)	A				x	x			

TABLE 1 (CONTINUED)

FISH

Species Number	Species Name	WASHINGTON HABITAT TYPES								
		Open Water	Rock	Sand	Mud	Mixed Coarse	Mixed Fine	Eel Grass	Kelp Bed	Man-made Structures
F-46	Kelp Greenling	x	x		x	x	x	x	x	
F-47	Rock Greenling	x	x?		x?	x?	x?	x?	x?	
F-48	Whitespotted Greenling	x	x?		x?	x?	x?	x?	x?	
F-49	Buffalo Sculpin		x							
F-50	Red Irish Lord	x	x		x	x		x		
F-51	Pacific Staghorn Sculpin	x	x	x	x	x	x	x	x	
F-52	Tidepool Sculpin	x	x	x		x	x			
F-53	Cabezon	x	x	x			x		x	
F-54	Redtail Surfperch	x		x						
F-55	Kelp Perch	x					x		x	
F-56	Shiner Perch	x	x	x		x	x	x		
F-57	Striped Seaperch	x		x			x	x		
F-58	Walleye Surfperch	x		x		x				
F-59	Pile Perch	x	x	x	x		x	x	x	x
F-60	White Seaperch	x								

TABLE 1 (CONTINUED)

FISH

Species Number	Species Name	WASHINGTON HABITAT TYPES Open Water	Rock	Sand	Mud	Mixed Coarse	Mixed Fine	Eel Grass	Kelp Bed	Man-made Structures
F-61	Penpoint Gunnel	x				x	x	x		
F-62	Saddleback Gunnel	x	x	x	x	x	x	x	x	
F-63	Crescent Gunnel	x	x			x	x		x	
F-64	Quillback Rockfish	x	x						x	
F-65	American Shad	A								
F-66	Pacific Herring	x	x	x?	x?	x?	x?	x	x?	x
F-67	Northern Anchovy	x	x?	x	x	x?		x		
F-68	Chinook Salmon (King)	A		x		x	x			
F-69	Coho Salmon (Silver)	A		x		x	x			
F-70	Pink Salmon (Humpy)	A		x		x	x			
F-71	Sockeye Salmon (Red)	A		x		x	x			
F-72	Chum Salmon (Dog)	A		x		x	x			
F-73	Masu Salmon (Cherry)	A								
F-74	Rainbow Trout (Steelhead	A				x	x			
F-75	Surf Smelt	x		x	x	x	x	x		

TABLE 1 (CONTINUED)

FISH

Species Number	Species Name	Open Water	Rock	Sand	Mud	Mixed Coarse	Mixed Fine	Eel Grass	Kelp Bed	Man-made Structures
		WASHINGTON HABITAT TYPES								
F-76	Longfin Smelt	A								
F-77	Eulachon	A								
F-78	Capelin	x		x?		x	x			
F-79	White Seabass	x							x	
F-80	Pacific Sand Lance	x	x?	x	x?	x?	x			
F-81	Spiny Dogfish	x	x	x	x	x			x	

*Where open water is checked for a species, the associated bottom/habitat types for that species is also checked. The habitat types checked are those mentioned in the literature for any life stage and does not imply that the species does not venture into other habitats.

Legend:

x = Species found in this habitat during some or all life stages.

A = Fish is anadromous.

? = Data is not specific and the habitat is assumed to be used by this species.

TABLE 2

FISH

WASHINGTON DATA GAPS

Species Number	Species Name	Critical Habitat Areas	Strait of Juan de Fuca Catch Summary	Coastal Catch Summary	General Systematic Census	Marine Life History	Spawning Areas	Nursery Areas	Feeding Areas	Migration Patterns	Possibly Unique Species To Washington Special Study	Too Few To Warrant Research	Remove From Significant Species List
F-1	Sablefish (Blackcod)	-	x	x		x							
F-2	Lingcod	-	x	x	x				x	x			
F-3	Pacific Sanddab	-	x	x	x	x							
F-4	Arrowtooth Flounder	-	x	x	x	x							
F-5	Petrale Sole	-	x	x			x						
F-6	Rex Sole	-	x	x		x	x						
F-7	Pacific Halibut	6	x	x	x		x						
F-8	Butter Sole	-	x	x			x						
F-9	Rock Sole	-	x	x	x		x	x					
F-10	Dover Sole	-	x	x	x		x	x					
F-11	English Sole	1	x	x	x		x						
F-12	Starry Flounder	2	x	x	x	x	x	x					
F-13	C-O Sole	-	x	x	x	x	x	x					
F-14	Curlfin Sole	-											

TABLE 2 (Continued)

FISH

WASHINGTON DATA GAPS

Species Number	Species Name	Critical Habitat Areas	Strait of Juan de Fuca Catch Summary	Coastal Catch Summary	General Systematic Census	Marine Life History	Spawning Areas	Nursery Areas	Feeding Areas	Migration Patterns	Possibly Unique Species To Washington Special Study	Too Few To Warrant Research	Remove From Significant Species List
F-15	Sand Sole	-	x	x	x		x	x					
F-16	Flathead Sole	-	x	x	x		x	x					
F-17	Slender Sole	-	x	x	x	x	x	x					
F-18	Plainfin Midshipman	-	x	x		x	x						
F-19	Pacific Cod	-	x	x		x	x	x		x			
F-20	Pacific Hake	-											
F-21	Pacific Tomcod	-	x	x		x	x	x					
F-22	Walleye Pollock	-	x	x	x		x						
F-23	Wolf-eel	-	x	x	x								0
F-24	Pacific Ocean Perch	-	x	x	x	x							0
F-25	Silvergray Rockfish (short-spine)	-	x	x	x	x	x						0
F-26	Copper Rockfish	-	x	x	x	x				x			
F-27	Puget Sound Rockfish	-	x	x	x	x	x	x	x	x	x		
F-28	Yellowtail Rockfish	-	x	x	x	x	x						

TABLE 2 (Continued)

FISH

WASHINGTON DATA GAPS

Species Number	Species Name	Critical Habitat Areas	Strait of Juan de Fuca Catch Summary	Coastal Catch Summary	General Systematic Census	Marine Life History	Spawning Areas	Nursery Areas	Feeding Areas	Migration Patterns	Possibly Unique Species To Washington Special Study	Too Few To Warrant Research	Remove From Significant Species List
F-29	Black Rockfish	-	x	x	x	x	x	x	x	x			
F-30	Bocaccio	-	x	x	x	x	x	x	x	x			
F-31	Yellow Rockfish (Red Snapper)	-	x	x	x	x	x	x	x	x			
F-32	Canary Rockfish (Orange)	-	x	x	x	x	x	x	x	x			
F-33	Chilipepper Rockfish	-	x	x	x	x	x						0
F-34	Redbanded Rockfish (Flag)	-	x	x			x						0
F-35	Rougheye Rockfish	-										x	x
F-36	Splitnose Rockfish	-	x	x	x	x	x					0	0
F-37	Greenstripe Rockfish	-	x	x	x	x	x					0	0
F-38	Brown Rockfish	-	x	x	x	x	x	x	x	x		0	0
F-39	Redstripe Rockfish	-	x x	x	x	x	x	x	x	x		0	0
F-40	Big Skate	1	x	x	x	x	x	x					
F-41	Longnose Skate	5	x	x	x	x	x	x					

TABLE 2 (Continued)

FISH

WASHINGTON DATA GAPS

Species Number	Species Name	Critical Habitat Areas	Strait of Juan de Fuca Catch Summary	Coastal Catch Summary	General Systematic Census	Marine Life History	Spawning Areas	Nursery Areas	Feeding Areas	Migration Patterns	Possibly Unique Species To Washington Special Study	Too Few To Warrant Research	Remove From Significant Species List
F-42	Ratfish	-	x	x	x	x	x	x	x	x			
F-43	White Sturgeon	2	x	x	x								
F-44	Green Sturgeon	2	x	x	x								
F-45	Cutthroat Trout (Coastal)	-	x	x	x	x							
F-46	Green Kelpling	-	x	x	x				x	x			
F-47	Rock Greenling	-	x	x	x				x	x			0
F-48	Whitespotted Greenling	-	x	x	x				x	x			
F-49	Buffalo Sculpin	-	x	x	x	x	x	x	x	x			
F-50	Red Irish Lord	-	x	x	x	x	x	x	x	x			0
F-51	Pacific Staghorn Sculpin	-	x	x	x	x	x	x	x	x			
F-52	Tidepool Sculpin	-	x	x	x	x	x	x	x	x			
F-53	Cabezon	-	x	x	x	x	x	x	x	x			
F-54	Redtail Surfperch	-	x	x	x	x	x	x	x	x			
F-55	Kelp Perch	-	x	x	x	x	x	x	x	x		0	

TABLE 2 (Continued)

FISH

WASHINGTON DATA GAPS

Species Number	Species Name	Critical Habitat Areas	Strait of Juan de Fuca Catch Summary	Coastal Catch Summary	General Systematic Census	Marine Life History	Spawning Areas	Nursery Areas	Feeding Areas	Migration Patterns	Possibly Unique Species To Washington Special Study	Too Few To Warrant Research	Remove From Significant Species List
F-56	Shiner Perch	-	x	x	x	x	x	x	x	x			
F-57	Striped Seaperch	-	x	x	x	x	x	x	x	x			
F-58	Walleye Surfperch	-	x	x	x	x	x	x	x	x			0
F-59	Pile Perch	-	x	x	x	x	x	x	x	x			
F-60	White Seaperch	-	x	x	x	x	x	x	x	x		0	0
F-61	Penpoint Gunnel	-	c	c	c	c							
F-62	Saddleback Gunnel	-	x	x	x	x							
F-63	Crescent Gunnel	-	x	x	x	x							
F-64	Quillback Rockfish	-	x	x	x	x	x	x	x	x			
F-65	American Shad	4	x	x	x	x	x	x	x	x			
F-66	Pacific Herring	-	x	x		x				x			
F-67	Northern Anchovy	-	x	x	x	x	x	x	x	x			
F-68	Chinook Salmon (King)	-	x	x	x	x		x	x	x			
F-69	Coho Salmon (Silver)	-	x	x	x	x		x	x	x			

TABLE 2 (Continued)

FISH

WASHINGTON DATA GAPS

Species Number	Species Name	Critical Habitat Areas	Strait of Juan de Fuca Catch Summary	Coastal Catch Summary	General Systematic Census	Marine Life History	Spawning Areas	Nursery Areas	Feeding Areas	Migration Patterns	Possibly Unique Species To Washington Special Study	Too Few To Warrant Research	Remove From Significant Species List
F-70	Pink Salmon (Humpy)	-	x	x	x	x		x	x	x			
F-71	Sockeye Salmon (Red)	-	x	x	x	x		x	x	x			
F-72	Chum Salmon (Dog)	-	x	x	x	x		x	x	x			
F-73	Masu Salmon (Cherry)	-										x	x
F-74	Rainbow Trout (Steelhead)	-	x	x	x	x							
F-75	Surf Smelt	5	x	x	x	x	x	x	x	x			
F-76	Longfin Smelt	-	x	x	x	x			x				
F-77	Eulachon	-	x	x	x	x	x						
F-78	Capelin	1	x	x	x	x	x						
F-79	White Seabass	-										x	x
F-80	Pacific Sand Lance	-	x	x	x	x	x	x	x	x			
F-81	Spiny Dogfish	-	x	x	x	x	x	x					

0 = Species will require the suggested additional research if not removed from the DOE species list.

? = Habitat used is inferred from a similar species of fish.

FISH VOLUME

NOTE TO THE USER

The user of these materials should have one additional source available:

Beak Consultants, Inc., 1975, Biological Oil Impact Literature Review - Volume II, Bibliography. Prepared for Washington Department of Ecology.

An additional and useful source for most of the fish species covered is:

Hart, J. L., 1973, Pacific Fishes of Canada. Fisheries Research Board of Canada. Bulletin 180. Ottawa.

FACT SHEET

F-1 SABLEFISH (BLACKCOD)

Anoplopoma fimbria

LIFE HISTORY - The sablefish is a migrating species that evidently moves into very deep water (500+ fathoms) during the winter months (166).

The sablefish has a life span of at least 20 years with first spawning in the fourth or fifth year (259). Spawning apparently occurs in January or February in British Columbia (166), winter months (J), and is reported March to May (B) in the Bering Sea.

Reproducing adults are reported along the open coast from September through February (446) and in the Bangor area of Hood Canal from December through February (780). A ripe female (off British Columbia) was reported from 137 fathoms (166). Fecundity is reported to be 100,000 to greater than 1,000,000 eggs (259). Eggs produced are pelagic and reported as bottom-oriented (446) and suface-midwater (166). They may well change vertical position with time. Post larvae (one inch) have been observed in May as surface pelagic inhabitants some 100 to 185 miles off Oregon (166). Juveniles in great schools have been occasionally seen north and south of Washington waters in inshore harbors (166). Young sablefish are positive phototactic (446). Young are seen inshore in shallower waters and may be a recruitment for deeper water commercial fisheries offshore (547). Sablefish reach a length of 40 inches or 126 pounds (166).

Tagging and racial studies indicate several more or less separate divisions of the West Coast stock: other tagging also shows extensive migrations (166). Adults are most often found deeper than 70 fathoms (547) to depths of 200 to

500 fathoms (166). These deeper depths are the location of commercial quantities of sablefish. Juvenile sablefish are commonly encountered in shallower water, including the Straits of Georgia and Juan de Fuca, and Puget Sound (166). They are caught at depths of 30 to 300 fathoms (J).

In addition to a movement to deeper water with age, seasonal movements are also noted. Sablefish are in shallower waters in Spring and Summer (259) and into deeper (259) or very deep (166) waters during the winter months.

Sablefish are indiscriminate feeders in captivity (166). Wild juveniles ate herring, euphausiids, and shrimp. Adults ate pollock, flounder, and rockfish (259). Other reported foods include saury, blue lantern fish, crustaceans, and small fish (166, 373).

WASHINGTON DISTRIBUTION - Sablefish appear to be a deep water species (as adults) who spawn pelagically and have post larvae/fry and juveniles appearing in abundance in shallower coastal waters. With age they appear to move into deeper water, although seasonal movements (shallow water: Spring, Summer; deep water: Winter) complicate conclusions about movement with age and size. These shallower waters include Straits of Georgia and Juan de Fuca and Puget Sound (166).

Records of catches of 50 or more sablefish are given for the Strait of Juan de Fuca (east end), Everett area, and Central Puget Sound (C). General catch records show some catches in the Central Sound to Seattle, with few records in South Sound (D). Only the north part of Hood Canal has sablefish records (D).

The main Washington fishing grounds are located between Destruction Island and Barclay Sound (Vancouver Island) and are fished in late Summer and Fall (J).

With the exception of East Sound (Orcas Island) records in the San Juan Islands, Bellingham area, and southern Strait of Georgia are not as numerous as Central Sound (D). Comparable catch record summaries have not been compiled for the western Strait of Juan de Fuca, coast, and bays of Washington. If the major population is offshore Washington (200 to 500 fathoms) as expected, the Washington coast could also be an area where juveniles are located. No sablefish records were found in recent Willapa and Grays Harbor studies (E, G).

HABITAT REQUIREMENTS - Sablefish utilize the open water habitat and are bottom-oriented most of their lives. The egg stage is pelagic and is reported both bottom-oriented and surface/midwater (446, 166). Fry are pelagic and surface-oriented (446). Juveniles are reported as pelagic surface and pelagic clay bottom-oriented (166, 259). Adults are pelagic, bottom-oriented, but appear near the surface at night (in vessel lights) (166). They make vertical migrations at night to feed and occur at different times throughout most of the water column.

The preferred bottom type appears to be a clay silt, sand-type bottom from various reports (405, 259).

CRITICAL HABITAT AREAS - While sablefish (partly grown) are commonly encountered in the shallower waters including Straits of Juan de Fuca and Georgia and Central Puget Sound (166, C) no specific areas stand out as critical. The catch records (D) show scattered catches throughout the areas that have had record catches and some fishing effort. These inside waters may well be an important place for juveniles to grow before they recruit into offshore adult commercial stocks

(547), but this is not known for certain. Therefore, no critical habitat areas are noted for sablefish in Washington waters. The bulk of the abundant (commercial) quantities of sablefish are well offshore and beyond state waters.

<u>DATA GAPS</u> - Little life history exists for this species in Washington waters. Sampling for eggs, post larvae, juveniles, and adults should be undertaken in the Straits of Juan de Fuca and Georgia and Central Sound as well as along the open coast to the three-mile limit. Sampling should be concentrated in the Spring and Summer when this species is in shallower waters and should utilize plankton, Issac-Kidd, and other midwater trawls and bottom trawls in a standardized fashion (covering the same water or bottom distance). The catch records for sablefish on the western Strait of Juan de Fuca and coast should be summarized as in (D).

<u>REFERENCES</u> - B, C, D, E, G, J, 166, 259, 373, 405, 446, 547, 780.

FACT SHEET

F-2 LINGCOD

Ophiodon elongatus

LIFE HISTORY - Life span of lingcod is 12 to 14 years for the male and 15 to 20 years for the female (21, 486, 544). The female matures at five years, the male at two years (544). Spawning takes place from December to March (166), with the spawning fish moving from offshore to inshore subtidal reefs (21) and to shallow waters, sometimes in the intertidal (166). The adhesive eggs are laid in large masses (15 to 30 lbs) in crevices or under rocks (166, 544). About 170,000 to 475,000 eggs are released in a single spawning (J). The male guards the egg mass (166, 486) until hatching in about six weeks (486). The hatched young sink to the bottom (in strong light) but after a few weeks the young fish are attracted to lights at night (166). Occasionally young are taken in beach seines on sandy beaches (166).

Lingcod exhibit two patterns of "behavior", little or no movement and some migrations (166). A possibly related phenomenon is movement with size, but conflicts appear in understanding this issue. One source (21) indicates large lingcod migrate more than small ones while another source (509) indicates large ones are more sedentary. Low salinity waters (Fraser River vicinity) were inhabited by large numbers of lingcod (166).

Food of juveniles is reported as copepods and other small crustaceans while adults eat herring, sand lance, flounder, hake, walleye pollock, cod, rockfish, crustaceans, octopus and other lingcod (166). Crab, squid, and shrimp are also reported (373, 381, 486, 544). Lingcod are large, high tropic level, predators (H). Lingcod grow to five feet (166) and are a highly prized SCUBA and hook and line recreational species.

WASHINGTON DISTRIBUTION - Lingcod are reported inshore and offshore (230 fathoms) in British Columbia and would be expected the same in Washington (166). Lingcod are indicated as numerous (50 + reports) in nearly all of north and central Puget Sound, Hood Canal, and the eastern Strait of Juan de Fuca (C). Single catch records are scattered throughout most of these inside waters except South Sound (Tacoma and south) (D). No similar record summary exists for the western Strait of Juan de Fuca, the coast, and coastal bays of Washington. Lingcod were not reported in Willapa Bay and Grays Harbor (E, F, G) but rocky habitat is not plentiful.

HABITAT REQUIREMENTS - The major habitat types required by lingcod are rock and open water, frequently among boulders, rubble, and reefs, usually in strong tidal current areas (K).

Spawning adults and eggs require a boulder or creviced rock surface for attachment and hinding of eggs. These areas are often on shallow reefs and into the low intertidal zone. Beyond the attached egg stage, the lingcod occupies the open water habitat type, but is bottom-oriented and can be found resting on the bottom. Mud/eelgrass habitat (shown by tow net) and rocky/kelp bed habitat (shown by SCUBA) are reported to have lingcod in common occurrence in North Sound studies (H). Mud/eelgrass habitat was occupied by juveniles only in May/June while adults were seen in rocky/kelp bed habitat in most months of the year (H).

Lingcod are most common in shallow waters (50 fathoms and less) in British Columbia waters (166) and presumably the same in Washington. They are reported near the bottom of the intertidal zone near kelp beds and reefs (J).

CRITICAL HABITAT AREAS - Lingcod would appear to have critical areas where spawning occurs as this would seem to occur in a small portion of the total area they inhabit. Areas of particular importance would include any shallow rocky reefs or low intertidal areas that are used by many spawning pairs (high density spawning). The literature reviewed does not document specific areas where high density spawning occurs or if spawning is so concentrated.

DATA GAPS - The western Strait of Juan de Fuca and coast catch records should be summarized for lingcod. In order to say more about lingcod, sampling areas would have to be expanded beyond present levels and areas to determine more about the temporal and spacial distribution of this species. This work should concentrate in suspected or known spawning areas, using SCUBA transects and hook and line sampling. Seasonal sampling and tagging in areas of extensive records would provide more details on the movement or lack of movement by this species. Food habits should also be evaluated in this species in various seasons and locations in Washington waters.

A concerted effort should be made to combine December to March SCUBA records of divers' (who keep such records) observations of lingcod spawning areas. As this information is summarized, biologist/divers should then attempt to confirm some of these observations, as well as begin to check similar habitats in areas unsurveyed by existing SCUBA observations. In this manner, critical habitat areas (dense lingcod spawning areas) could be located and documented on maps. Divers records of sighting large numbers of lingcod in other months would also be useful.

REFERENCES - C, D, E, F, G, H, J, K, 21, 166, 373, 381, 486, 509, 544.

FACT SHEET

F-3 PACIFIC SANDDAB

Citharichtys sordidus

LIFE HISTORY - This flatfish is a species more common in shallow waters, and is generally distributed and fairly common in British Columbia waters (166) and Washington waters (C, D). Little life history information exists. Fifty percent of the females mature at age three with spawning in February in Puget Sound (166). Eggs of the Pacific sanddab are reported in the Bangor area (Hood Canal) in July to September (780). This may be explained by a possible second spawning by the female (166). On the southern Washington coast, reproducing adults are reported in February, May, and August (534). Reproducing adults are reported in Hood Canal in March through May (459) and July through September (780). All seasons are reported as having reproducing adults in California with spawning in July through early September (213).

In one study (256), adults moved from 11 to 22 fathoms by day to slightly shallower (8 to 16 fathoms) waters at night. They fed at night in shallow waters (8 to 11 fathoms) (256). Although more common in shallow waters, the Pacific sanddab has been found to 167 fathoms (166).

Food of adults, in one study, was found to be 21 percent echinoderms, 21 percent shrimp, and 16 percent polychaetes (percent by volume) (256). Small clams, crustaceans, and some algae are also reported (780).

Pacific sanddab reach a length of 16 inches (166) and are incidental commercial species. This species comprises an important segment of the flatfish sport catch (K).

WASHINGTON DISTRIBUTION - Catch records of 50 or more are recorded for inside waters at Everett area, Seattle area and the central Puget Sound (C). Lesser records are reported for all other areas covered in this study (C). No similar record summaries exist for the western Strait of Juan de Fuca and Washington coast. The location of catch records (D) shows scattered samples in all areas except the Strait of Georgia and eastern Strait of Juan de Fuca (except catches west of Protection Island). This may be explained by fish distribution or by lesser sampling effort in these areas. This species was not captured in North Sound studies (H). This species was listed for Grays Harbor, but the speckled sanddab (*C. stigmaeus*) was discussed and may be meant in the species list. Another survey (I) reported small catches of Pacific sanddab from deeper depths (10 to 20 meters in Cherry Point vicinity and Guemes Channel in July, September, and January). No sanddab were taken in East Sound and none were taken at any stations in late winter and spring. Sanddabs, among other fish, are said to utilize Willapa Bay as nursery area (E).

HABITAT REQUIREMENTS - The Pacific sanddab utilizes the open water habitat type but is very bottom-oriented as juveniles and adults, probably to sand, mixed-fine, and mud habitat types (based upon foods eaten). They are reported abundant on sand in depths over 50 feet (K).

Eggs of the Pacific sanddab are pelagic and are said to be midwater (213) and bottom-oriented (166). Larval stages following the egg stage may also be pelagic. Juveniles and adults are pelagic and bottom-oriented to the probable substrate types mentioned above for feeding and protection.

CRITICAL HABITAT AREAS - No areas of extensive Pacific sanddab numbers stands out in the data base reviewed. Areas of concentrated spawning, nursery grounds, and adult concentration areas may exist, but were not located in these data. No critical habitat areas can be defined.

DATA GAPS - See arrowtooth flounder (F-4).

REFERENCES - C, D, E, H, I, K, 166, 213, 256, 459, 534, 780.

FACT SHEET

F-4 ARROWTOOTH FLOUNDER ("TURBOT")

Atheresthes stomias

LIFE HISTORY - Little information was located for arrowtooth flounder. This flounder is a deep-water flatfish. The male matures between the 7th and 13th years. In the Bering Sea they spawn from December through March (mostly in January and February) (B). They are believed to be winter spawners in our vicinity (780). Reproducing adults in the northeast Pacific are seen in November and December (150 to 220 fathoms) in 2.3 to 3.5 C water with a 33.5 to 34.1 ppt. salinity (21). Eggs are large, non-adhesive and apparently bathy pelagic (B). Eggs and early larvae are carried extensively by currents (21). The young of most all pleuronectids are restricted to very shallow waters for the first year (780). A general pattern of young occupying shallower waters than adults is seen (21).

Diet varies with age (21). Larvae eat copepods and their eggs; adults eat herring, shrimp, krill, sanddabs, and miscellaneous fish (166).

This flounder reaches a length of 33 inches (166) and is a minor commercial ground fish in Washington. This flounder is taken in sport fisheries (K).

WASHINGTON DISTRIBUTION - Catch records of 50 or more are reported in inside Washington waters for the Everett area, central Puget Sound, and Seattle area (C). Catch records are scattered throughout these inside waters with the exception of the Strait of Georgia (D). Comparable record summaries do not exist for the western Strait of Juan de Fuca, and coast of Washington. Arrowtooth flounder were not captured in recent North Sound studies (H, I), Grays Harbor studies (G), or Willapa Bay (E).

The arrowtooth flounder (adult) is reported down to 400 to 500 fathoms and young are reported at depths greater than 380 fathoms (166).

HABITAT REQUIREMENTS - Arrowtooth flounder use the open water habitat throughout their life cycle but are bottom-associated as juveniles and adults.

Eggs and fry (larvae) are located in midwater (21) in water temperatures of 3.5 to 6.5 C. Adults are pelagic bottom-associated with inorganic silt bottom (A). Bottom types may include sand, mud, mixed-fine habitat types. This flounder is caught over sand or soft bottoms at depths over 80 feet (K).

CRITICAL HABITAT AREAS - None can be defined as the general habitat requirements and life history of arrowtooth flounder are not greatly understood. Data available is too general to provide specific area information where this species may (or may not) concentrate during various life stages.

DATA GAPS - Little is reported about the life history and spacial and temporal distribution of this species in Washington waters. A good initial step would be to compile the catch records for this species in the western Strait of Juan de Fuca and Washington coast as per sources (C, D).

Plankton sampling of eggs/larvae and bottom trawling of juveniles and adults on open sand/mixed-fine/mud bottoms should be completed to check past areas of concentrated records for this species (C, D) and to explore similar habitat not yet sampled or little sampled in the past. Sampling should be timed to winter spawning and the expected appearance of young in shallower waters after spawning.

REFERENCES - A, B, C, D, E, G, H, I, K, 21, 166, 780.

FACT SHEET

F-5 PETRALE SOLE

Eopsetta jordani

LIFE HISTORY - The life span of petrale sole is 25 years for females and 19 years for males (166). Males mature at seven years and females at eight years but this varies by area (166, 544). Spawning occurs in deep water (120 to 250 fathoms, 544) in winter (November to March, 21; January to April, 544). Fecundity in large females was 400,000 and 1,200,000 eggs (544). The success of spawning is dependent on oceanographic and meteorological conditions (166). There is evidence of more or less separate stocks along the West Coast of North America with northern British Columbia stocks spawning in the Esteban Deep (200 fathoms) off central Vancouver Island and some other stocks (Forty-Mile Bank) spawning in the Willapa Deep (166).

The eggs produced are pelagic and float close to the surface where prevailing winds drive them towards the Northeast (166). When the eggs encounter lower salinity (less dense) waters (nearer shore) they sink before reaching shallow shore waters (166). In the laboratory eggs hatch in eight to nine days in 7 C water (544, 166). The larvae produced remains pelagic and juveniles become more bottom-oriented (10 to 39 fathoms) with time (544). With time they move from shallow to deeper waters to recruit into deepwater adult populations.

Seasonal migrations are known. A southerly offshore spawning migration occurs in winter and a northerly inshore movement occurs in summer (21).

Foods of petrale sole vary with availability, locality, and season, and include euphausiids, sand lance, herring, shrimp, and a wide variety of bottom fish and invertebrates (166). By percent of occurrence, foods included euphausiids (40 percent), herring (24 percent), sand lance (16 percent), and shrimp (9 percent) in one study, (481).

Petrale sole reach 27 inches and are an importnat commercial ground fish in Washington. The species is labeled the most valuable of any of the soles (J). Few are taken by sportsmen (K).

<u>WASHINGTON DISTRIBUTION</u> - Petrale sole are located in commercial quantities at 170 to 250 fathoms in winter, and at 40 to 70 fathoms the rest of the year (166, K). They have been found from the surface to 300 fathoms (166). In the inside waters of Washington, no defined regions had 50 or more records of petrale sole, but a few records were recorded for all areas (C). This sole is reported as almost completely absent from Puget Sound (J). Scattered catches are reported in all areas of Washington's inside waters (D) with the only noticeable concentration of records in the Seattle vicinity (probably the most heavily sampled area). No comparable catch record summary exists for the western Strait of Juan de Fuca and Coast of Washington. Petrale sole were not reported in recent North Sound surveys (H, I) nor in the Grays Harbor study (G).

Offshore trawling grounds in the winter are on the deep water spawning concentrations (J). Formerly (pre 1953) there were spring and summer fisheries in shallower waters (J).

HABITAT REQUIREMENTS - The petrale sole utilizes the open water habitat type and becomes bottom-associated with age. Eggs are pelagic and midwater (481). Juveniles and adults are pelagic/bottom-associated or bottom-oriented (A). Silt, sand, and mixed-fine bottom types are substrates mentioned (A).

CRITICAL HABITAT AREAS - If the petrale sole is similar to generalized pleuronectids and is restricted to very shallow waters for the first year of life (780) these areas would seem critical in Washington waters, particularly in the Straits of Juan de Fuca and Central Sound, assuming offshore spawned eggs enter those areas. The open coast and bays may also be important to petrale sole as Willapa Bay is reported to be for other soles (E, F).

No specific information exists to pinpoint general habitats or temporal and spacial abundance of this species, so no critical habitats are defineable.

DATA GAPS - The petrale sole's spawning area(s) offshore Washington (Willapa Deep and others?) could use more study - to determine the area, depths, and times of spawning. The shallow water first year of life needs to be more fully understood. Shallow water sampling on and over suitable substrates should be carried out with plankton nets and bottom trawls, to determine the abundance of petrale sole by regions with time.

The catch records of this species should be summarized for the western Strait of Juan de Fuca and coastal Washington as per sources (C, D). Based upon these summaries and sources (C, D), spring, summer and fall sampling should be completed to check past catch records and to check areas not yet sufficiently sampled at depths between 40 to 70 fathoms.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 21, 166, 481, 544, 780.

FACT SHEET

F-6 REX SOLE

Glyptocephalus zachiris

LIFE HISTORY - The life span is long, up to at least 24 years (166). Little is known about this species' life history (166). Spawning in Hecate Strait is thought to occur in March or early April (166) while another source (780) indicates winter as the spawning season. In the Bering Sea (Pribilof Islands and farther east, over water 35 to 55 fathoms deep) eggs were found from mid-July to the end of August (B). Larvae are found on the open coast in April and May (461). Young are not found inshore, but occasionally juveniles (about one year old?) occur in shallow waters and down to 60 fathoms (166). Larger juveniles are found deeper (80 fathoms). Larger individuals may be at intermediate depths before adulthood, where rex sole have been located to 400 fathoms (166).

Rex sole reach a length of 23.2 inches (166) and are a minor commercial groundfish species.

WASHINGTON DISTRIBUTION - The rex sole is generally distributed through coastal British Columbia (166) and Washington (C, D). Rex sole range is from the surface to 400 fathoms (166). Inshore Washington record summaries indicate 50 and more catch records of rex sole in the Everett area, Hood Canal, Central Puget Sound, Seattle area, and South Puget Sound (C). Actual catch records (D) for the inside waters indicated this species is scattered through all areas except parts of the Straits of Georgia and Juan de Fuca of major juvenile development (possibly in shallower waters not yet sampled) if rex sole are patterned similar to other pleuronectids.

REFERENCES - A, B, C, D, E, F, G, H, I, 166, 461, 780.

(probably the lowest sampling effort areas). Recent North Sound studies (H, I) and Grays Harbor and Willapa Bay studies (E, F, G) do not report this species. Rex sole are apparently more abundant in waters deeper than 200 fathoms.

HABITAT REQUIREMENTS - The rex sole utilizes the open water habitat type but become bottom-associated with age. Egg and larvae distribution in the water column were not located. Juveniles and adults are bottom-associated and pelagic/bottom-oriented on mixed fine, silt, and medium sand bottom types (A).

CRITICAL HABITAT AREAS - There is no life history and little distribution information for rex sole in Washington waters. Shallow waters may not be as critical for this species as for other pleuronectids based on the reported (166) occasional catches of small (one year old?) rex sole in shallow waters. No areas can be defined on this available data.

DATA GAPS - All stages of this species' life history would need to be studied in Washington waters to determine where they spawn, where eggs and larvae go and how juveniles recruit into the adult population (in 200 to 400 fathom waters). An initial step would be the compilation of catch records as per sources (C and D) for the western Strait of Juan de Fuca and coastal Washington. With this and sources (C and D) trawling should be completed quarterly to check prior records of abundance and to sample areas with little or no past sampling and with suitable bottom type. Plankton net sampling should also be completed in the vicinity of located spawning areas to determine the movement of eggs and larvae and the location

FACT SHEET

F-7 PACIFIC HALIBUT

Hippoglossus stenolepis

LIFE HISTORY - The Pacific halibut has been studied in detail because of its commercial importance. The life span is long - more than 35 years (J). On the average females mature at 12 years (between 8 and 16) and males mature considerably younger (166). A large female will produce two to three million eggs (166). They spawn at 150 to 225 fathoms of water in winter (J). Eggs and larvae are pelagic for four to five months, with eggs mainly concentrated between 55 and 109 fathoms (166). With growth the post-larvae fish rise in the water (predominantly about 55 fathoms) by three to five months and are carried inshore by currents to become established on the bottom in six to seven months (166). With growth and age they move to deeper waters (166). After five to seven years they are available in off-shore commercial fisheries (166).

Movement is related to size and maturity. Mature fish make extensive migrations (1,000 miles) related to spawning, while immature fish usually make only restricted migrations on and off the feeding and fishing grounds (166).

Food consists of fishes, crabs, clams, squids, and other invertebrates (166). Also mentioned is zooplankton and worms (370, 373).

The Pacific halibut reaches a length of eight feet nine inches (166) and is both an important commercial as well as recreational fish species in Washington.

WASHINGTON DISTRIBUTION - Pacific halibut range to 600 fathoms but are most common between 30 and 225 fathoms (166). Compared to other flatfishes, the Pacific halibut has a much reduced distribution in the inside waters of Washington, with 50 or more records only for the eastern Strait of Juan de Fuca and with "10 to 49 records" for the Admiralty Inlet area (C). Specific catch records show the bulk of the eastern Strait of Juan de Fuca catches to be offshore Ediz Hook and Dungeness Spit and lesser records in Skunk Bay and Admiralty Bay (D). The pattern of records may extend out the Straits of Juan de Fuca and to the northern coast areas but these are not summarized. This catch record indicates that unlike the other flatfishes, Pacific halibut rarely come into the Sound farther than the eastern Strait of Juan de Fuca and Admiralty Inlet. Pacific halibut are reported in coastal bays and throughout the Straits of Juan de Fuca and along the outer coast, becoming less common to the southward in 75 feet and deeper water (K). Recent North Sound studies (H, I) have not captured this species, nor has it been reported in Willapa or Grays Harbor studies (E, F, G).

HABITAT REQUIREMENTS - Pacific Halibut use the open water habitat type but become bottom-associated in the juvenile and adult stages.

Eggs are pelagic and midwater (between 22 and 511 fathoms, but concentrated between 55 and 109 fathoms (166). Newly hatched larvae are pelagic and midwater (deeper than 109 fathoms) and come into shallower water (about 55 fathoms) by three to five months (166). At about six to seven months the Pacific halibut becomes established on the bottom (166).

This flatfish would be expected on sand and mixed-fine type bottoms from the juvenile of six to seven months through adulthood.

Commercial fishing occurs on offshore banks in 10 to 150 fathom waters (J). In inside coastal bays, Pacific halibut occur on sandy bottoms usually at depths greater than 75 feet (K).

CRITICAL HABITAT AREAS - With the documented catch record summary (C, D), concentrations appear in 12 to 13 fathoms and deeper off Ediz Hook and Dungeness Spit in the Strait of Juan de Fuca. Green Point and Crescent Bay are also mentioned (K). They may exist in other parts of the Straits farther west. The concentration of catches at these locations as well as in Skunk Bay and Admiralty Bay indicate Pacific halibut utilize these limited areas regularly. Sport catches in these areas are in the summer and fall. These halibut are probably coming from deeper waters to feed in these shallower waters when food is abundant. These areas are mapped as presently known critical habitat areas (F-7) on attached maps, because they appear to represent the Pacific halibut's near shore feeding grounds (that are known) in Washington's waters.

DATA GAPS - Western Strait of Juan de Fuca and coastal catch summaries should be completed for Pacific halibut. The early life history of halibut in Washington waters was generally presented from data located. Sampling for eggs and larvae should be attempted in the Strait of Juan de Fuca, Admiralty Inlet, and coastal Washington in the spring and summer to see if quantities of eggs or larvae come into any specific areas. Shallow trawling should follow to determine densities of juvenile halibut in these areas. SCUBA observations may be useful if water clarity exists in any of the areas of noted abundance. Larger trawl sampling should be made of the recognized catch areas (Ediz Hook, Dungeness Spit, etc.) to determine the seasonal abundance of halibut on a more quantified basis.

REFERENCES - C, D, E, F, G, H, I, J, K, 166, 370, 373.

FACT SHEET

F-8 BUTTER SOLE

Isopsetta isolepis

LIFE HISTORY - The butter sole has a recorded life span of eleven years (female) and ten years (male) (166). Life history information is scarce. Spawning takes place from February (Bellingham Bay) to late April (166). A large female can produce one million eggs (544). Eggs are reported demersal in Skidegate Inlet, British Columbia (166). A depth stratification was seen in Hecate Strait, British Columbia, with young inshore.

Migrations are not extensive (544), but there is a summer movement to shallow water and in winter to deeper water (166). North-south migrations are restricted to spawning (166).

Food of butter sole includes marine worms, young herring, shrimp, and sand dollars (166). Other foods reported are small mollusks, crustaceans, echinoderms (370). Polychaetes, clams, crabs, and sand lance are also reported (381).

Butter sole reach a length of 18 inches (166) and are a minor commercial species.

WASHINGTON DISTRIBUTION - Butter sole are reported as more common at greater depths (97) but are found in shallow water (166). They are recorded to depths of 150 to 200 fathoms (166). Off the Washington coast buttersole were only in the trawl catches of 1 to 49 fathoms (370). Reports from British Columbia and Bellingham Bay indicate this species prefers inside waters and is said to be rare off the southern point of Vancouver Island and in the Strait of Georgia

(166). The catch record summary for inside waters (C) indicates 50 or more butter sole records for Georgia Strait, San Juan Islands, Bellingham, and Everett areas. The actual records (D) are scattered in the inside waters with no records in the southern two-thirds of Hood Canal and the numerous records in Bellingham and Everett areas. Ongoing North Sound studies (H) report juvenile butter sole as an uncommon occurrence in October in the sand/eelgrass habitat (shown by beach seine). Another recent study (I) reports butter sole as the most abundant at Cherry Point of the three stations sampled. Catches were greatest in deeper waters (15 to 20 meters) and occurred primarily in July and September (I). Catches were generally lowest in winter and spring (I).

Butter sole were not captured in a recent Grays Harbor survey (G).

HABITAT REQUIREMENTS - Butter sole utilize the open water habitat but become bottom-associated in the juvenile through adult stages. They were reported in silty depressions in shallow waters of northwest Hecate Strait (British Columbia) in the summer (166). Silt bottom is reported elsewhere (260). Juveniles may be similarly located in shallow waters.

CRITICAL HABITAT AREAS - Little information exists for the butter sole. This February spawning in Bellingham Bay is of interest but other spawning areas exist to the north (166) and may, in fact, exist in some of these other Central Sound areas (i.e., Everett) where catch records are numerous (D).

Eelgrass/sand habitat may be important to juveniles (H).

No critical areas are definable using the data reviewed.

DATA GAPS - More information is needed on the location and timing of spawning concentrations of butter sole in Washington waters. January through April trawling in regions of concentrated records (D) with silty or sand bottoms would indicate spawning areas. Another early effort should be the compilation of catch records for the western Strait of Juan de Fuca and coastal Washington as per sources (C, D). Any catch concentrations shown by this effort should also be trawled in January to April to seek spawning grounds. Unsampled or little sampled areas of appropriate bottom and depth should also be sampled.

In the vicinity of spawning areas shallow trawls and beach seines should focus on the sand/eelgrass habitats seeking concentrations of juvenile butter sole.

REFERENCES - C, D, E, F, G, H, I, 97, 166, 260, 370, 381, 544.

FACT SHEET

F-9 ROCK SOLE

Lepidopsetta bilineata

LIFE HISTORY - Life span is 22 years (female) and 15 years (male) (166). Spawning occurs from late winter to early spring (780) between February and April (166). Females can produce 1.3 million eggs (166). Spawning is near the bottom. Eggs are demersal and adhesive (166). They hatch in nine to eighteen days, depending on temperatures (6.5 to 8 C). (166). Young are found in shallow waters on beaches in some localities (166). Juveniles were reported most abundant at 5.5 to 8 fathoms and primarily at the shallow depth at dusk (256).

The rock sole is in deeper water in winter than in summer and fall (93) and is in shallower water at night that during the day (93). Shoreward migrations to shallower waters were noted in the spring (770).

Food of rock sole includes mollusc siphons, clams, polychaete worms, shrimps, small crabs, brittle stars, and sand lance (166). Juveniles fed on 45 percent polychaetes and 51 percent small crustaceans (mysids, amphipods, 208); adults 38 percent polychaetes, 28 percent molluscs and sand land (percent by volume) in one study (256). Feeding is reported in midmorning (256).

Rock sole reach a length of 23.5 inches (166) and are a minor commercial and sport species in Washington.

WASHINGTON DISTRIBUTION - Rock sole occur to 200 fathoms but are scarce below 100 fathoms (166). Off British Columbia they are mostly caught between 20 to 30 fathoms and are reported in shallower water. Winter depths were reported in Port Orchard as 11 to 16 fathoms in winter and 5.5 to 11 fathoms in summer and fall and rock sole were shallower (5.5 to 11 fathoms) at night than during the day (93). A similar pattern was reported (256) for Duwamish Head with slightly deeper water feeding (8 to 11 fathoms) during the day.

The rock sole catch summary (C) indicates 50 or more catch records for most all the inside waters of Washington. The actual catch records (D) show scattered records from throughout these inside waters with possibly greater reports from the Central and South Sound. Comparable record summaries do not exist for the western Strait of Juan de Fuca and the coast.

In an ongoing North Sound study (H) rock sole occurred uncommonly in the sand/eelgrass, gravel, and cobble habitats (as shown by beach seine). Rock sole juveniles were seen in the sand/eelgrass habitat in October (H). Adult rock sole were seen (H) as follows:

Sand/eelgrass	-	August-September
Gravel	-	July and November
Cobble	-	June, July, and February

In another study (I) rock sole were more abundant at Guemes Channel as compared to Cherry Point and East Sound and were caught primarily at the middle depths (five to eight fathoms) sampled (I).

Rock sole were not reported in Grays Harbor (G) and were not specifically noted in Willapa Bay (E, F).

HABITAT REQUIREMENTS - Rock sole utilize the open water habitat, but are bottom-associated from the adhesive egg stage through adulthood. Rock sole are found in and below the intertidal zone over pebbles or mixed sand and pebbly bottoms (K). This species shows a preference for sandy gravel and is not common on sand (103). Rock sole prefer firm, rapidly sloping bottoms, less than 22 fathoms deep (256). Sand/eelgrass, gravel, and cobble, may be important habitats.

CRITICAL AREA HABITATS - While nursery areas for young rock sole probably exist in North, Central and South Sounds, and Hood Canal, specific reference to concentrated spawning and nursery areas were not located. It is of note that spawning grounds of the largest Canadian stocks (north of Vancouver Island and Hecate Strait) have not been located (166). The present information base and the scattered nature of this species in inside waters of Washington prevents any critical habitat area designations.

DATA GAPS - Catch records for the western Straits of Juan de Fuca and coast should be compiled. Based upon this compilation and that of present sources (C, D), areas of abundance should be checked between February and April to locate spawning areas. Areas of little previous sampling effort of the correct bottom type and depth should be surveyed. Any located spawning areas should be followed up with adjacent shallow water sampling of mixed-coarse and mixed-fine bottoms to look for eggs/larvae/juveniles to see if nursery areas of any magnitude exist.

REFERENCES - C, D, E, F, G, H, I, K, 93, 166, 770, 780.

FACT SHEET

F-10 DOVER SOLE

Microstomus pacificus

LIFE HISTORY - Dover sole fecundity is reported as great as 230,000 eggs/female (166). Females mature at 45 cm, males at 39 cm (166). Spawning in California occurs from November to February (166). Winter spawning in deeper offshore waters (250 to 500 fathoms) is reported (J). Eggs and larvae are pelagic (21). There is indication of a drift of eggs and young southward and shoreward due to prevailing ocean currents (404, 21). The pelagic life is prolonged in dover sole (404, 166) for several months and metamorphosis is delayed. Young may be still pelagic at 100 mm and the delay affects their distribution (166). Young are presumed to settle in shallower waters and, as they grow, move to deeper waters where adults are located.

Migrations do not appear extensive, but northward movements of 110 miles and southward movements of 366 miles from fishing grounds off Washington have been observed (166). Inshore migrations (to shallower waters are observed in the summer and offshore movements to deeper waters are made in winter (404). Normally, dover sole are abundant on fishing grounds (60 to 200 fathoms?) in May and early June and leave for deeper waters in October and November (J).

Dover sole feed on burrowing forms (166) eating mud-dwelling invertebrates (21, 370). Small bivalves, scaphopods, sipunculids, polychaetes, nematodes, echinoids, ophiuroids, gastropods, shrimp, and demersal eggs are reported (404).

Dover sole reach a length of 28 inches (166) and are becoming an important commercial species in Washington.

WASHINGTON DISTRIBUTION - Dover sole are located to 600 fathoms and are generally distributed on suitable bottom throughout coastal British Columbia (166) and, presumably, Washington. They are taken in Puget Sound only in limited quantities (J). Records of dover sole catches indicate this species is scattered throughout the inside waters of Washington (C, D). Similar catch summaries do not exist for the western Strait of Juan de Fuca and coast. In nearshore North Sound studies dover sole were not taken (H). In another survey (I) dover sole were more abundant at Cherry Point than at Guemes Channel and East Sound. Dover sole was totally absent from the shallow 27 fathom station at all sites, from East Sound at all depths, and from all winter and spring samples (I). Dover sole were not specifically reported in Grays Harbor and Willapa Bay (E, F, G).

HABITAT REQUIREMENTS - Dover sole utilize the open water habitat type and are pelagic as eggs/larvae and post larvae longer than most flatfish before becoming bottom-associated as juveniles and adults.

Eggs are reported as pelagic and bottom-associated (A). Larvae are pelagic.

Adults appear to favor soft bottom (166) and this is reported from "muck" to medium sand (A). Mud and fine sand would appear a common substrate.

CRITICAL HABITAT AREAS - The scattered records for inside waters and deep offshore spawning(at undefined places) does not point to any critical areas in Washington waters. The prolonged metamorphosis may scatter progeny of dover sole or at least decentralize their nursery area requirements as compared to other flatfish who come to shallow water in smaller sizes.

No critical habitat areas were located on the basis of this information.

DATA GAPS - The spawning areas should be better defined by sampling offshore Washington. A starting point would be to summarize catches by location for the coast and western Strait of Juan de Fuca. The effort beyond that would follow that for rock sole (F-9).

REFERENCES - A, C, D, E, F, G, H, I, J,21, 166, 370, 404.

FACT SHEET

F-11 ENGLISH SOLE

Parophrys vetulus

LIFE HISTORY - The life span of English sole is 15 to 17 years (136), 12 to 18 years (209). Males mature at three years, females at four years (136). Fecundity in large English sole is up to two million eggs (544). Spawning occurs from December to March and the eggs are pelagic in 28 ppt. salinity water (544). Spawning is recorded from 30 to 40 fathoms (767). Eggs hatch to larvae in 60 hours at 8 C (544) and movement depends on currents (21). Hatching is reported at 98 hours at 10.6 C (166). Young are pelagic for six to ten weeks (166, 544). Metamorphosis occurs in mid-April (544). The young settle out onto sand beaches (770) and migrate to deeper waters as they grow. Major influxes of new juveniles was noted in December to March and May to July in Puget Sound (103).

English sole eggs are transported toward shore when the larvae develop and are apparently swept into coastal estuaries, such as Grays Harbor (G). The larvae develop and, upon metamorphosis, settle and/or migrate to shallow sand bottom areas in the estuary, which serve as nursery grounds (G). Bays and estuaries are labeled as vital to English sole in their first year of life (L).

Separate stocks of English sole are noted between Central and South Sound (764). Extensive migrations are noted (522), other migrations are described as small (544) probably depending on the study areas involved. The general off coast migration is south in the fall and north in the winter (915). English sole also move to deeper waters with age (depths from 70 to 300 fathoms,166) Juveniles at about 100 mm begin to move to deeper water, moving with the tide, lagging behind the incoming tide (103).

Diel depth changes are noted. Juvenile English sole are most abundant at 16 to 21 fathoms by day and are in less than five fathoms at night when they feed; adults are most abundant at 5 to 21 fathoms by day when they feed and less than eight fathoms at night when they feed (256). Juveniles are particularly noted in shallower waters at night (93).

Juveniles feed at dusk and dawn (93). Adults apparently feed by day (256). The English sole is small-mouthed and main foods are clams and clam siphons, other small molluscs, marine worms, small crabs, shrimps, and brittle stars (166). Sand lance, squid and small fish are also reported (544).

English sole grow to a length of 22.5 inches (166) and are an important commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - The English sole is found to 300 fathoms with commercial quantities at less than 70 fathoms (166). In British Columbia, the species is generally distributed along the coast with small isolated populations at the heads of many inlets (166) and this is probably also true in Washington. English sole is a shallower water flatfish and is the most common commercial flatfish in Puget Sound with most landings in late winter and early spring (J). Puget Sound accounts for 20 percent of the annual Washington landings (J).

In a catch record summary of inside waters, 11 of the 12 subdivisions have 50 or more reports of English sole with Colvos Passage the only area with 10 to 49 records (C). Colvos Passage is a fairly small area relative to the other subdivisions. English sole are the most reported flatfish in this summary. Actual catch records (D) are scattered all over these inside waters, with greater numbers of records in Central and South Sound, as compared to North Sound and the eastern Strait of Juan de Fuca. No similar catch summary exists for the western Straits or coast of Washington.

In an ongoing North Sound study (H), English sole juveniles are reported as commonly occuring in the mud/eelgrass, sand/eelgrass, gravel habitats (shown by beach seine) and uncommon in mud/eelgrass and rocky/kelp bed (shown by tow net) and common in cobble (shown by tow net). Juvenile English sole were in most of these habitats all year round, except the cobble habitat, where these fish were not seen January-April (H). Larval English sole were seen in March-May in most of these habitats (H). In another recent North Sound study (I), English sole was the most abundant species of fish in beam trawl catches at three stations - Cherry Point, Guemes Channel, and East Sound. Of these areas, English sole were least abundant in East Sound, and abundance of this species was higher in shallower water (2.7 to 5.5 fathoms) and higher in summer than winter, with depths sampled to 11 fathoms (I).

In Grays Harbor, English sole were reported as the most consistently abundant species, being abundant at all stations in June to September although less abundant in October to May (common in North Channel Stations 1 and 2 - winter only) and in Westport seines (Whitcomb Flats) (G). English sole were otherwise uncommon in other October to May stations, except two South Channel stations where they were not taken (G). A pattern of larger sizes of English sole to deeper waters was noted in Grays Harbor (G). Moon Island Flats were noted as a major juvenile English sole nursery area in Grays Harbor for the entire yearly sampling period (G).

English sole are probably one of the "several species of sole" that utilize Willapa Bay (E, F) in much the same way as reported for Grays Harbor. No specific areas are given.

HABITAT REQUIREMENTS - English sole utilize the open water habitat but become bottom-associated in the juvenile and adult stages.

Eggs and young are pelagic in the open water habitat and position in the water column is salinity-dependent. Eggs would originate from spawning areas of suitable bottom type in 30 to 40 fathoms (767).

Juveniles and adults are bottom-associated on sand and soft bottoms in the intertidal zone and deeper (K). Bottom types reported are silt, sand, medium sand, eelgrass, "pulpy peat", and "boulder" (A). Preferred bottom from this survey (A) and food types would appear to be silt to sand-type bottoms. Mud is not mentioned, but may be "silt" in some cases. Eelgrass areas are also important (H).

CRITICAL HABITAT AREAS - English sole seem quite dependent on the shallow, soft-bottomed areas of bays and estuaries as nursery areas in their first year of life. Although more areas surely exist, the literature reviewed indicates one area, the Moon Island Flats (Grays Harbor) as a major nursery area. This is labeled F-11 on attached maps. Similar area(s) probably exist in Willapa Bay and a much more detailed assessment of catches of English sole would be necessary to pinpoint expected nursery areas in inside waters of Washington.

Spawning areas may also be critical if the English sole concentrate in restricted areas. Such areas were not located.

DATA GAPS - Catch records of English sole in the western Strait of Juan de Fuca and coast need to be summarized. Using this summary and sources (C, D), December to March concentrations need to be sampled seeking spawning areas of great magnitude and other unsampled areas of appropriate depth and bottom should be so sampled. See previously described species F-9.

Studies comparable to the Grays Harbor effort should be continued there to look at annual variations and begun in Willapa Bay to judge its importance to English sole as a "coastal bay nursery area" (E, F).

REFERENCES - A, C, D, E, F, G, H, I, J, K, L, 21, 93, 103, 136, 166, 209, 256, 522, 544, 764, 767, 770, 915.

FACT SHEET

F-12 STARRY FLOUNDER

Platichthys stellatus

LIFE HISTORY - Starry flounder are shallow water euryhaline flatfish noted for a wide tolerance of bottom types and salinities (G). Starry flounder mature at two years (male) and three years (female, 166, 408). Spawning occurs in shallow waters (less than 25 fathoms, 776) in Puget Sound in February to April (166). Fecundity was not reported. Eggs are "slightly lighter than sea water" and non-adhesive (166). Hatching times are 110 hours and 68 hours at 10.5 C and 12.5 C respectively (408). Metamorphosis is probably in January to February (408). A fairly rapid rate of growth is maintained through the first spring and early summer, and from July through October the rate declines with acceleration in January and rapid growth in the second spring (408). With age juveniles would be expected to move into deeper water, but still shallow relative to most other flatfish.

Migration is not extensive with one record of movement of 125 miles, moving north of the Columbia River mouth (166). They migrate with the tide, lagging behind the incoming tide (103) but are said not to migrate very much (166).

Adult feeding is diurnal and oriented slightly off the bottom (281, 124). Most intensive feeding is between July and October and feeding ceases when temperatures are coldest (January to May or June) (281,124,166). Food of young starry flounder are barnacle larvae, cladocerans, and copepods and their namplii; of larger juveniles, marine worms, copepods, and amphipods; of adults, crabs, shrimp, worms, clams, molluscs, small fish, and brittle stars (166, 776).

Starry flounder grow to a length of 36 inches (166) and they are an important commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - Starry flounder are common on sandy or soft bottoms in and below the intertidal zone and also often in estuaries and the lower portions of coastal streams (K). They have been found in excess of 150 fathoms but are mainly found in shallow waters (166). They are reported commercially taken to depths of 150 fathoms (G). Starry flounder are reported in 50 or more records in most inside areas summarized (C). The actual locations of starry flounder catches are scattered in all Puget Sound waters with the bulk of the records on the eastern side of these waters and the eastern Strait of Juan de Fuca catches restricted to shallow nearshore areas (i.e., near Ediz Hook, Dungeness Spit, Sequim Bay, etc.).

Starry flounder were found in "scattered abundance" in recent North Sound studies at Cherry Point, Guemes Channel, and East Sound (I). Most were taken at the shallowest depth (2.7 fathoms) of the first two stations while none were taken at this depth in East Sound (I). None were taken at the deepest depth (11 fathoms) at the first two stations (I). In an ongoing North Sound study (H), starry flounder were of common occurrence in the mud/eelgrass and sand/eelgrass habitat (shown by beach seine) and the mud/eelgrass habitat (shown by tow net). Uncommon occurrence was reported for gravel and cobble habitats (H). Starry flounder (adults) were in the sand/eelgrass habitat most of the year (H). Adults were seen in gravel and cobble habitats primarily in July-September (H). Juvenile starry flounder were seen throughout the year (except May) in the mud/eelgrass habitat (H).

Starry flounder were called abundant in South Channel of Grays Harbor and in lesser abundance in other areas in June through September (G). They were generally uncommon or absent from stations in October through May (G). Starry flounders from deeper trawled areas were larger, compared to those beach seined from shallower areas (G). Starry flounder have been found in the upper harbor and lower Chehalis River during the entire year with greatest abundance from late May to mid-October with juveniles maturing in upper Grays Harbor (218). Willapa Bay may have similar patterns for starry flounder as they are reported to utilize the Bay as a nursery area (E, F). Starry flounder are labeled abundant throughout the tide flat and shallow water areas of Willapa Bay (E).

The starry flounder is abundant in the Columbia River up to Puget Island, often being caught in the salmon net fishery (H. O. Wendler, WDF, personal communication).

HABITAT REQUIREMENTS - Starry flounder utilize the open water habitat type, but are bottom-associated except for the egg and larval stages, which are pelagic. They are found to 150 fathoms but are more common in shallower waters (166). They are noted for a wide tolerance of bottom types and salinities (G). Bottom types include silt, "pulpy peat", mud, mixed fine, and mixed medium, sand, eelgrass, and boulder (A). They appear to only avoid rock bottoms (408).

This euryhaline species lives in coastal water bays, sloughs, and freshwater (776). Salinities as low as 6 to 10 ppt. are tolerated (166). Young starry flounder are most abundant in estuarine areas and frequently move some distance into rivers (776).

CRITICAL HABITAT AREAS - Bays and estuaries appear critical to starry flounders, both inside and coastal areas. However, the critical areas noted are large and only involve coastal bays. All of Willapa Bay is labeled a nursery area (E, F) and this is probably also true of Grays Harbor. Inside of these coastal bays the estuary of the Chehalis River (218) and probably the Willapa River appear to be important for starry flounder. These areas are labeled F-12 on attached maps.

Similar areas probably exist for bays and estuaries in inside waters of Washington but more catch evaluations would be necessary to determine these.

DATA GAPS - Catch records for starry flounder should be summarized for the western Strait of Juan de Fuca and coast. Based upon these summaries and sources (C, D), concentrations of starry flounder should be sampled in February to April, looking for major spawning populations. Tagging and early life history studies should follow at areas of starry flounder concentration. Sampling should follow that for flatfish species (F-9).

Grays Harbor sampling should be repeated for several years to look at annual variations and a similar program should begin in Willapa Bay and Columbia River estuary.

REFERENCES - A, C, D, E, F, G, H, I, 103, 124, 166, 218, 281, 408, 776.

FACT SHEET

F-13 C-O SOLE

Pleuronichthys coenosus

LIFE HISTORY - Information on C-O sole is scarce. Spawning occurs in late winter (780). Eggs are pelagic, with near neutral buoyancy (166). Eggs hatch in 12 days at 13.8 C (166). If the pattern of most pleuronectids is followed, eggs and larvae are moved to shallower waters where juveniles develop and with growth move into deeper water areas. C-O sole are not deep-water flatfish (to 191 fathoms) (166).

Long migrations are not recorded. They do move to deeper water in winter (5.5 to 11 fathoms) as compared to summer and fall (5.5 fathoms) (93). In summer the young are common in shallow water, while adults frequently inhabit deeper waters (166). C-O sole are shallower at night (5.5 fathoms) than during the day (93).

Food of C-O sole includes polychaetes, clam siphons, small invertebrates, fish, molluscs, and crabs (504, 780, 945).

The C-O sole grows to 14 inches (166) and is a minor sport fish in Washington.

WASHINGTON DISTRIBUTION - C-O sole are recorded from 10 to 191 fathoms (166) and are rare in the intertidal zone (103). C-O sole catch records for inside waters show 50 or more records in Central Puget Sound, Port Orchard, Seattle area, and South Sound (C). Actual records (D) show few reports in San Juan Islands, Strait of Georgia and the eastern Strait of Juan de Fuca. No comparable catch summary exists for the western Straits or coast of Washington.

Recent North Sound studies (I) did not capture C-O sole. Ongoing North Sound studies (H) report C-O sole as commonly occurring in cobble habitats and uncommon in gravel habitats (as shown by beach seine). C-O sole are not reported in the coastal bays (E, F, G). Adults were seen in the gravel habitat in July, February, April, and September, and in the cobble habitat in July-August and October (H).

HABITAT REQUIREMENTS - This species utilizes the open water habitat, but is bottom-associated except for the egg and larval stages. Bottom types are recorded as very fine sand, mixed/very fine, fine sand, and medium sand (A). It is of interest that they were captured in cobble (common occurrence) and gravel (uncommon occurrence) habitats by beach seine. They may well utilize all these bottom types, possibly at different age stages. Food types would indicate a mud to sand bottom for feeding. The British Columbia distribution (166) would indicate a preference for more inside waters which may hold for Washington also.

CRITICAL HABITAT AREAS - Little information is available for C-O sole habitat requirements and critical habitat areas do not stand out from the data reviewed.

DATA GAPS - Catches of C-O sole should be summarized for the western Strait of Juan de Fuca and coast. With this and other sources (C, D), areas of concentration in past records should be resurveyed as suggested for other flatfish (F-9).

REFERENCES - A, C, D, E, F, G, H, I, 93, 103, 166, 504, 780, 945.

FACT SHEET

F-14 CURLFIN SOLE

Pleuronichthys decurrens

LIFE HISTORY - Little is known about curlfin sole life history. Time of spawning is assumed to be winter and in coastal waters (as this flatfish is not reported in inside waters - C,D). The only information to indicate it is in Washington is that it is reported in California (depths 21 to 291 fathoms) to British Columbia and southeastern Alaska (166).

Eggs are pelagic with neutral buoyancy (166). Eggs hatch after about seven days at 13.8 C (166).

Foods are reported as polychaetes, nudibranchs, and lectibranchs (504).

The curlfin sole grows to 12 inches (166) and is not an important commercial or sport fish species in Washington.

WASHINGTON DISTRIBUTION - No information was located for Washington's inside waters. A few are reported for coastal waters, 10 to 200 fathoms (258). In British Columbia they are reported as abundant on Hecate Strait Flats where young predominate (166). No curlfin sole are reported from coastal bays (E, F, G).

HABITAT REQUIREMENTS - They are known from 21 to 291 fathoms in California (166) and 10 to 200 fathoms on the Washington Coast (258). They probably occur on sand and mixed fine type bottoms.

CRITICAL HABITAT AREAS - Curlfin sole are uncommon in Washington waters with a few record catches. If they are this scarce in Washington waters, this flatfish should possibly be removed from a "significant species" list for Washington waters.

DATA GAPS - Curlfin sole do not seem abundant enough to warrant special research attention.

REFERENCES - C, D, E, F, G, 166, 258, 504.

FACT SHEET

F-15 SAND SOLE

Psettichthys melanostictus

LIFE HISTORY - The sand sole is a shallow water flatfish, not recorded deeper than 100 fathoms (166). Life span is over ten years (262). Males mature at two years and females in three years (262). The spawning period extends from January in Puget Sound to the end of March in Bellingham Bay (166). In Bellingham Bay spawning peaks between mid-February and mid-April (124). The eggs are pelagic and slightly less dense than sea water (166). They hatch in five days at 7 to 9 C (166). Larvae are pelagic for six months and small juveniles may remain in the surface plankton (103). Juveniles are infrequent in the intertidal (103). Another source (776) reports the eggs slowly sinking before hatching and the young sole spending their first year in shallow estuarine and intertidal zones. Free-swimming juveniles are reported to "migrate in" to Grays Harbor (218).

Extensive migrations are not reported. The movement of eggs/larvae/juveniles to shallower waters and the movement to deeper waters (100 fathoms) with age is reported (780, 218).

Sand sole in Bellingham Bay feed by day on or in the benthos (124). Feeding is reported to take place with little interruption throughout the year in Washington (166). Foods reported are fishes (speckled sanddabs, herring, anchovies), crustaceans, worms, and molluscs. Anchovies were found in Grays Harbor sand sole (G).

The sand sole grows to 24.8 inches (166) and is a sport fish species in Washington.

WASHINGTON DISTRIBUTION - Sand sole are taken below the intertidal zone on sand bottoms (K) but not deeper than 100 fathoms (166). Records of inside water catches of sand sole show 50 or more records for nearly all areas (C). The actual areas of the catches as summarized for inside waters (D) show sand sole in shallower areas and not in deeper parts of the easterly Strait of Juan de Fuca. Similar catch summaries do not exist for the western Straits and coastal Washington.

In a recent North Sound study of Guemes Channel, East Sound, and Cherry Point (I), sand sole were most abundant in East Sound, but were not taken there in shallow stations (2.7 fathoms). The seasonal abundance was much more even than in some other species caught (I). In an ongoing North Sound study (H), sand sole (juveniles) were reported as common occurrence in sand/eelgrass habitat and uncommon in mud/eelgrass and gravel habitats (as shown by beach seine). They were located in the mud/eelgrass habitat in July and September, in the gravel habitat in April, and in the sand/eelgrass habitat all year except December (H).

In Grays Harbor studies (G), sand sole showed sharp seasonal changes. In winter this flatfish was uncommon in Westport beach seines and absent from all harbor stations, while in summer they were present in all study areas, being most abundant in South Channel and at Whitcomb Flats (G). A definite size pattern emerged with larger sand sole occurring in outer areas of the harbor (G).

Sand sole are not specifically reported in Willapa Bay but are probably included as "several species of sole" using Willapa as a nursery area (E, F).

HABITAT REQUIREMENTS - The sand sole uses the open water habitat, but becomes bottom-associated apparently after a prolonged pelagic existence as egg/larvae/young juvenile (103). Bottom types include silt, mixed/fine, sand, and sand/medium (A). North Sound studies reported most in a sand/eelgrass habitat and fewer in a mud/eelgrass and gravel habitat (H).

CRITICAL HABITAT AREAS - The sand sole appears well distributed over most of this study area. Bellingham Bay (for spawning), Grays Harbor and Willapa Bay (for nursery areas) stand out as important areas for sand sole based on the data reviewed. However, no specific sites in these general areas are noted as specifically important and no areas are therefore mapped for sand sole. Many bays in Central and South Sound may be similarly important for spawning and/or nursery areas for sand sole.

DATA GAPS - Catch records for sand sole in the western Strait of Juan de Fuca and coast should be compiled. Based upon this summary and sources (C, D), a comprehensive study of sand sole could be started in Bellingham Bay, Central and South Sound, Grays Harbor, and Willapa Bay, and other areas of known sand sole concentrations. January to March sampling should be completed to locate larger spawning areas and studies follow as described from other flatfish (F-9).

REFERENCES - C, D, E, F, G, H, I, K, 103, 124, 166, 218, 262, 776, 780.

FACT SHEET

F-16 FLATHEAD SOLE

Hippoglossoides elassodon

LIFE HISTORY - In Puget Sound males mature at two years and females mature at three years, however, spawning condition may be found at one year (both sexes?) (166). Spawning occurs from March to late April (166). Fecundity is reported as great as 600,000 eggs/female (260). Eggs are spawned near the bottom (15 to 25 fathoms) and float to the surface after about eight hours (260). Eggs sink in less than 27.5 ppt. salinity (260). Eggs sink 12 to 24 hours before hatching (260). Hatching is reported in 9 to 20 days, depending on temperature within the range of 9.8 to 2.4 C (166). Metamorphosis occurs at three to four months (260). Fry are seen in Hood Canal, and in southern Puget Sound in April and May (461). Sparse numbers of flathead sole were reported as bottom-associated in Port Orchard in September, October, January, and March (93). Larvae and young juvenile flathead sole were not reported as present in East Sound (260).

Migration information is almost lacking, with the only report that no diel movements occur for flathead sole (93).

Generally, feeding is depressed in low winter temperatures and by spring spawning with two exceptions: (1) Juveniles feed most actively in the warming spring, and (2) The largest adults feed most actively on spawning herring in winter (260). In Puget Sound clams and worms are eaten (166).

Crustaceans are also reported (166). Food, as reported by one source (260), follows:

Juveniles (40 to 170 mm), mysids, few polychaetes in spring, 54 percent empty from December to March.

Adults (180 to 259 mm), mysids, shrimp, few fish, clams, polychaetes, 55 percent empty from December to May.

Adults (260 to 319 mm), mysids in June to December, fish in January to May, shrimp, few clams, polychaetes, 49 percent empty in December to June.

Adults (320 to 440 mm), fish in November to May, mysids, shrimp, and clams in June to October, 73 percent empty from April to May, 47 percent empty July to October.

The flathead sole grows to 18 inches (166) and is a minor sport fish species in Washington.

WASHINGTON DISTRIBUTION - The flathead sole is reported to 300 fathoms but occurs mainly (British Columbia and southeast Alaska) between 150 to 200 fathoms, with young common at shallow depths (166). In East Sound, flathead sole are usually found at 15 to 25 fathoms (260).

Catch summaries for inside waters of Washington indicate 50 or more records of flathead sole for San Juan Islands, Bellingham area, Everett area, and Port Orchard, and no records in only one area, Colvos Passage (C). Actual catch records for these waters show few reports in Georgia Strait and catch records in the eastern Strait of Juan de Fuca are primarily on the south shore in Sequim Bay and Port Discovery and not in the open and deeper waters (D). No similar summary exists for the for the western Strait of Juan de Fuca or coast.

Flathead sole are not reported in two recent North Sound studies (H, I). They are not reported in Grays Harbor (G), nor specifically mentioned in Willapa Bay (E, F).

HABITAT REQUIREMENTS - Flathead sole utilize the open water habitat but become bottom-associated after metamorphosis and later in life. Eggs and larvae are pelagic varying in location in the water column from surface to bottom, depending on time of egg development and salinity of the water.

Adults on the coast favor 150 to 200 fathom water with young flathead sole common in shallow depths (166). The bottom type in several studies is silt (A). Flathead sole are reported common over soft bottoms at moderate depths (K). Based upon these observations, mud and mixed fine habitat types would seem to be those used by flathead sole.

CRITICAL HABITAT AREAS - Flathead sole seem well distributed in inside waters and no critical areas stand out. East Sound has an abundance of eggs reported but is not apparently a nursery area as larvae and young juveniles were not present (260). The concentrations of catch records in bays and passages of Central and South Sound (D) would indicate other spawning areas probably exist in some of these areas. No detailed information was located on coastal Washington flathead sole.

Based upon the data reviewed, no critical areas stand out for flathead sole. East Sound does have spawning in or nearby based upon egg catches.

DATA GAPS - The catch records of flathead sole for the western Strait of Juan de Fuca and coast should be worked up and with this and sources (C, D), areas of concentration should be resurveyed in March to April to seek significant spawning areas. The flatfish survey should then follow that described for earlier flatfish species (F-9).

REFERENCES - A, C, D, E, F, G, H, I, K, 93, 166, 260, 461.

FACT SHEET

F-17 SLENDER SOLE

Lyopsetta exilis

LIFE HISTORY - Little is known about the slender sole's life history. Males (50 percent) mature at 14 cm and females (50 percent) at about 16 cm (166). The slender sole spawn in Puget Sound in April (166). Eggs and larvae are assumed pelagic and would be carried to shallow waters (if not spawned there) where young would develop in the first year if the general pattern of pleuronectids holds for slender sole.

Migrations of any extent are not reported. No diel migrations are made (93).

Food of slender sole is small invertebrates (780).

The slender sole grows to 13.7 inches (166) and is not an important commercial or sport species in Washington.

WASHINGTON DISTRIBUTION - Slender sole are reported at shallow to moderate depths (to 280 fathoms, California) (166). It is taken throughout coastal British Columbia (166) and is similarly reported in Washington (534).

In inside Washington waters, slender sole are reported with 50 or more catch records in the Everett area, Central Puget Sound, Port Orchard, Seattle area, and South Puget Sound (C). Hood Canal has intermediate records and all other areas have fewer than ten reports (C). Actual catch records for these waters indicate few slender sole records in the eastern

Strait of Juan de Fuca and North Sound area (D), possibly related to deeper depths and more extensive rock substrate. In lower Hood Canal, this flatfish was abundant in deep water, but with few ripe females suggesting a feeding pattern, rather than a spawning area (770).

Slender sole were not captured in recent North Sound studies (H, I), nor are they reported for Grays Harbor (G) or specifically for Willapa Bay (E, F).

Offshore southern Washington coast, slender sole are reported (534) as follows:

69.5 fish/km trawled (65 to 98 fathoms) - February
116 fish/km trawled (44 to 87 fathoms) - May
80 fish/km trawled (32 to 87 fathoms) - August

HABITAT REQUIREMENTS - The slender sole utilizes the open water habitat type and becomes bottom-associated in the juvenile and adult stages after metamorphosis. Location of pelagic eggs and larvae was not found in the literature reviewed. The bottom types mentioned for juveniles and adults includes silt, sand, "mixed: medium", eelgrass, medium sand (A).

CRITICAL HABITAT AREAS - Too little is known of the life history and habitat requirements of slender sole to define any critical areas. Coastal bays are not used as nursery areas while the inside waters of Washington may be used as nursery and feeding areas for recruitment to larger adult stocks offshore. No definite areas stand out at this time.

DATA GAPS - Slender sole catch records should be summarized for the western Strait of Juan de Fuca and coast. With this summary and sources (C, D). Surveys at concentrations in March to May should be resurveyed to locate spawning concentrations and studies should follow as described for other flatfish (F-9).

REFERENCES - A, C, D, E, F, G, H, I, 93, 166, 534, 770, 780.

FACT SHEET

F-18 PLAINFIN MIDSHIPMAN

Porichthys notatus

LIFE HISTORY - The plainfin midshipman is a wide-ranging species (intertidal to 145 fathoms, 166), which also moves vertically at night to feed. Spawning is reported in the spring (166, 780) and summer (780) after adults move from deeper to shallow waters (770). Polygamy may occur (166). Eggs are laid in shallow water in the intertidal zone within a cavity scooped out in sand or broken shell under rocks (166). Eggs are attached by an adhesive disc to the rock of the cavity's roof and are guarded by a fasting male (166). A nest usually contains 200 to 500 eggs (166). The young hatch in 16 to 20 days and the larvae become free-swimming (32 to 34 mm). At this stage and through adulthood they avoid light by digging into the bottom by day and moving out at night to feed (166).

Migrations are less in winter than summer (93). A fall abundance increase in lower Hood Canal due to the influx of young was reported (770). Adults move from deep water to shallow water during spring and summer (770) in spawning migrations. As noted, the species also moves vertically from the bottom (day) to midwater areas at night (93, 166).

Food of 32 to 34 mm young is small crustacean larvae, while adults eat fishes and crustaceans (166). Euphausiids are reported as food (373).

The plainfin midshipman grow to a length of 15 inches (166) and are not an important commercial or sport fish species.

WASHINGTON DISTRIBUTION - Plainfin midshipman occur from the intertidal zone to 145 fathoms (166). Catch record summaries of 50 or more records were found in most all subdivisions of inside Washington waters (C). Less than ten reports of plainfin midshipman were reported for Georgia Strait and Strait of Juan de Fuca, Admiralty Inlet, and Colvos Passage (C). Actual locations of catch records (D) indicate few records in the deeper waters of the eastern Strait of Juan de Fuca and North Sound (D). In the San Juans, East and West Sound have the bulk of the records (D). Hood Canal and Puget Sound, south of Admiralty Inlet have numerous reports (D). One ongoing North Sound study reports this species as uncommonly occurring in the mud/eelgrass and cobble habitats (as shown by tow nets) (H). Plainfin midshipman were seen in August in the mud/eelgrass habitat and in September in the cobble habitat (H). In a recent North Sound trawl study (I) of Cherry Point, Guemes Channel and East Sound, this species was abundant in July and September in deeper stations (8.2 to 11 fathoms). Seasonally the midshipman was least abundant in winter and spring at all three locations (I).

No similar record summary exists for the western Strait of Juan de Fuca or coast. Midshipman would be expected on the Washington coast similar to the west coast of Vancouver Island where they are reported (166).

The species was not reported in Grays Harbor (G) and Willapa Bay (E, F).

HABITAT REQUIREMENTS - Pacific midshipman utilize the open water habitat except in the egg stages and during daylight periods as juveniles and adults.

Eggs are attached to a rock substrate in what is apparently a mixed coarse habitat type (boulders with adjoining sand or broken shell bottoms). Rock ledges and crevices might also be used where pockets of sand and broken shell areas exist.

Larvae are pelagic. Juveniles and adults are pelagic (midwater, 166) in the night period when feeding, and buried in the bottom in the daylight period. The bottom types that juveniles and adults bury themselves into include sand, "mixed: medium", eelgrass, very fine sand, silt, and shell fragments (A). These would probably include sand, mud, mixed coarse, mixed fine and eelgrass bed habitat types.

CRITICAL HABITAT AREAS - The plainfin midshipman is scattered throughout inside Washington waters and may similarly be distributed in the western Strait of Juan de Fuca and North Coast where suitable substrate exists. No specific areas of concentrated spawning, feeding, or nursery ares were located in the literature reviewed. No critical areas were therefore located.

DATA GAPS - Catch summaries of plainfin midshipman for the western Strait of Juan de Fuca and coast should be completed. With these summaries and sources (C, D), areas of historic concentration should be surveyed in spring and summer looking for mature individuals preparing for spawning. SCUBA observations might be useful where visibility permits to look for the males guarding nests to get some idea of spawning density in areas where spawning concentrations are expected. The shallow life history stage of this species seems the most critical in terms of the total area they inhabit and where man is most likely to impact them. The major effort in studying this species should therefore be concentrated on spawning and early life history stages.

REFERENCES - A, C, D, E, F, G, H, I, 93, 166, 373, 770, 780.

FACT SHEET

F-19 PACIFIC COD

Gadus macrocephalus

LIFE HISTORY - The Pacific cod is an abundant demersal fish species in Washington waters. Life spans are short - probably six years (544). Females first mature at two to three years, males (50 percent) are mature at two years (166). Fecundity is reported as 1.2 million eggs (60 cm female) and 3.3 million eggs (78 cm female) (166). Spawning occurs in Winter (166, 544) and late Winter (780). The eggs are at first demersal (166, 544) and slightly adherant (166) and conflicting opinions exist on the benthonic nature of the eggs until hatching (166). Hatching occurs in:

11.5 days at 8 C (544)
8 to 9 days at 11 C (166)
17 days at 5 C (166)
about four weeks at 2 C in northern waters (166).

Another source (J) reports eggs are not deposited near the bottom and float freely until hatched. The larvae (fry) are reported in midwater (97) and grow fast. Adults reach 50 cm in two years (166) so growth is fast.

Pacific cod do not make long-range migrations but considerable local movement is seen (544). Pacific cod are a schooling fish (K), congregating for spawning (moving to deeper waters in the Fall) and dispersing for feeding into shallower waters in the spring (166, 780, 445). Discovery Bay vicinity tagging indicated movement into Central Puget Sound and as far away as the North California Coastline and Strait of Georgia (522).

Pacific cod also make vertical movements in feeding, ascending at night (97, K) off the bottom to seek selected foods.

Food of young is copepods, while adults eat a wide variety of invertebrates (worms, crabs, molluscs, shrimp) and of fish (herring, sand lance, walleye, pollock and flatfish) (166).

The Pacific cod grows to 39 inches (166) and is both important as commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - The Pacific cod is usually demersal but occasionally is taken in quite shallow water (166). They have been taken to 300 fathoms (166). Commercial fishing in Washington is in 5 to 100 fathoms (J).

Catch records for inside waters show 50 or more reports of Pacific cod in all 12 subdivisions of Puget Sound waters (C). Actual distribution of these catch records (D) indicate few Pacific cod have been taken in the lower half of Hood Canal. They have generally come from nearly all the other inside water areas. No similar summary exists for the western Strait of Juan de Fuca and coast.

In the North Sound trawl study at Cherry Point, Guemes Channel, and East Sound, no Pacific cod were taken (I). In an ongoing North Sound study, juvenile Pacific cod were reported as occurring uncommonly in the sand/eelgrass habitat (as shown by beach seine) (A). They were taken in the sand/eelgrass in July, in the cobble in August to September, and in the gravel in June (H).

This species was not reported in recent Willapa Bay and Grays Harbor studies (E, F, G).

HABITAT REQUIREMENTS - The Pacific cod uses the open water habitat type but is bottom-associated in possibly all life stages, with the exception of midwater larval stages and night adult movements up the water column to midwater or surface positions. Pacific cod are reported usually as moving, schooling, fish near a smooth, firm bottom in more than thirteen fathoms of water (K). The bottom types reported include very coarse and silt (A). Sand/eelgrass habitat is also reported for juveniles (H). From these examples Pacific cod would appear to use a wide variety of bottom excluding rock. Sand, mixed: coarse, and mixed: fine, bottoms are expected to be the main ones used.

CRITICAL HABITAT AREAS - The Pacific cod appears well distributed through most of the study area and no areas of concentration as feeding, spawning or nursery areas stand out. Congregations of cod probably exist in deeper waters for spawning (winter) and some shallow water areas (spring and summer) may be nursery and feeding areas of importance. However, the data is not specific enough to label such areas so that no critical areas were located.

DATA GAPS - Conflicts exist in early life history information for Pacific cod. The position of eggs and larvae may well reflect salinities of receiving waters but this needs further study. As described for other species, the first step will be to complete a catch record summary for this species for the western Strait of Juan de Fuca and coast. This summary and sources (C, D) should then be studied and winter concentrations should be resampled by trawl, seeking large spawning concentrations of Pacific cod. Once located, these areas of concentration should be sampled with plankton-type nets at water depths from surface to bottom, looking for eggs and larvae. An understanding of the physical oceanography of the spawning grounds would be helpful in projecting eggs and larvae trajectory and this would assist their sampling. Once eggs and larvae are located STD profiles should be made and specific gravity of eggs and larvae taken to better understand the location of eggs and larvae at one station and be able to extrapolate to areas with somewhat different oceanographic conditions.

Another study (spring-summer) should focus on young Pacific cod in shallow waters and should seek significant concentrations in nursery areas. Tow nets, small trawls, and beach seines could be employed depending on the substrate and depth at which the fish are located. Tagging of young would be of secondary interest to see where these shallow water Pacific cod move to in fall and winter for several years following their capture.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 97, 166, 445, 522, 544, 780.

FACT SHEET

F-20 PACIFIC HAKE

Merluccius productus

LIFE HISTORY - The Pacific hake is a pelagic species of moderate life span - 13 years (142) or 16 years (319). Sexual maturity is reached in three to four years (males) and four to five years (females) (142). Fecundity is reported as great as 496,000 eggs/69 cm female (166). Mature hake are found in May in Puget Sound (166). Spawning in Port Susan is reported between February and May (142). Spawning in offshore waters is reported in February to April (780). Spawning occurs in pelagic waters (319). Hake eggs are pelagic (166, 212) and hatch in about three days (166). Larvae are relatively undeveloped at hatching (212). Larvae are presumed to remain pelagic on through the juvenile and adult stages.

Conflicting viewpoints on movements of Pacific hake are reported. The northern population (found in the Puget Sound area) is said to migrate to Southern California and Baja, California, in the winter months (319), while another source (142) indicates no mixing of Puget Sound and ocean stocks. Migration of adults in the northern range is in spring/summer/fall and in southern parts in winter (21). An explanation of movement in Central Sound is as follows:

> "After 1.5 years, young hake leave Port Susan in Fall and scatter in Puget Sound. Mature adults congregate in Saratoga Passage in the Fall and spawn in Port Susan between February and May, and then scatter for the Summer" (142).

Coastal populations migrate offshore to deeper water in winter (780). Only non-spawning adults are seen on the Washington coast in spring to fall (540). Adults are thought to migrate northward in the spring and southward beginning in the fall to the offshore spawning region (453).

Hake also make vertical migrations from their usual position, five to 15 fathoms off the bottom (142), to shallower depths in the evening during feeding. School of hake rise and disperse in the water column during the evening (453). Hake are suspected of occasionally occupying intermediate water layers (166).

Feeding is believed primarily between twilight and darkness (540). Hake are also labeled "mainly nocturnal feeders" (166). Foods of young hake are copepods and their eggs, while adults (off British Columbia) eat euphausiids and sand lance primarily, and to a lesser extent herring, smelt, anchovy and shrimp (166).

The Pacific hake grows to about 36 inches (166) and has potential commercial importance and is a minor sport fish in Washington.

WASHINGTON DISTRIBUTION - Hake are found from the surface to 491 fathoms (166). In inside Washington waters, catch summaries indicate 50 or more reports of hake in the Everett area, Hood Canal, Central Puget Sound, Port Orchard, Seattle area, and south Puget Sound (C). Colvos Passage has no reports, while Admiralty Inlet, Bellingham area, and San Juan Islands have fewer than ten reports (C). The actual geographic positions of the catches is concentrated in the Central and South Sound regions with few in the eastern Strait of Juan de Fuca and north (D). No comparable record summary exists for the western Strait of Juan de Fuca and coast of Washington.

Pacific hake were not taken in two North Sound studies (H, I) nor in Grays Harbor (G) or Willapa Bay studies (E, F) - all shallow water studies.

HABITAT REQUIREMENTS - Pacific hake utilize the open water habitat throughout their pelagic life cycle. This schooling fish usually is found over smooth bottom in water deeper than 25 fathoms (K). Hake may be abundant just off the bottom (5 to 15 fathoms) (142) or on the surface (frequently occurs at night) (K). Hake are found concentrated in coastal bays and harbors (inside waters?) in late winter and early spring where they are commercially taken by local trawlers (K).

Juvenile hake are reported over sand, mixed: medium, and eelgrass bottoms; adults are over silt and sand, mixed medium, and eelgrass bottoms (A). This source (A) also labels them bottom-oriented and bottom-associated in some studies but most studies indicate a pelagic/midwater habitat.

CRITICAL HABITAT AREAS - Only one spawning area in inside waters - Port Susan - was mentioned although others in South Sound and Hood Canal probably exist. Specific areas in Port Susan were not described in the secondary sources reviewed. Offshore spawning regions are mentioned but not specifically described. No critical habitats were determined for Pacific hake.

DATA GAPS - An initial effort should be to summarize any catch records for the western Strait of Juan de Fuca and open coast of Washington. With this information, acoustic surveys, like those completed by the University of Washington in Port Susan beginning in 1969, should be initiated in areas of historical catches. Test fishing with trawls might be necessary where additional species occur. Both inside and coastal waters to three miles should be surveyed.

REFERENCES - A, C, D, E, F, G, H, I, K, 21, 142, 166, 212, 319, 453, 540, 780.

FACT SHEET

F-21 PACIFIC TOMCOD

Microgadus proximus

LIFE HISTORY - Little is known about this species (166). The Pacific tomcod is believed to spawn in the winter months (780). No life span, age of maturity, or fecundity information was located for the tomcod. Eggs and larvae may be pelagic or near the bottom if they are like other codfishes.

Long migrations are not reported. They do ascend in the water column at night (97) probably in feeding depths located in one study (93) was 22 fathoms (day) and 5.5 to 22 fathoms at night with juveniles in midwater at night in the summer. Tomcod are labeled a "migrating, schooling, fish" (K).

Feeding probably occurs mainly at night if they are like cod and feed up in the water column. Foods include shrimp, copepods, mysid larvae, pandalid mysis, megalops larvae (262, 166). Winter feeding emphasized euphausiids, shrimp and crabs (478). Other foods noted were anchovies and polychaete worms (780).

The Pacific tomcod reaches a length of 12 inches (166) and is a sport and commercial fish species in Washington.

WASHINGTON DISTRIBUTION - Pacific tomcod are reported as deep as 120 fathoms (California) and never abundant but distributed along the British Columbia coast between 15 and 50 fathoms (166). A similar pattern is expected in

Washington. Tomcod catch summaries for inside waters (C) show this species is abundant in nearly all 12 subdivisions with only the Strait of Juan de Fuca having fewer than ten reports. The geographic record for inside waters (D), show scattered catches throughout the inside waters except the eastern Strait of Juan de Fuca and numerous records in some bays and narrow passages.

In a recent North Sound study of Cherry Point, Guemes Channel, and East Sound (I), tomcod were caught primarily at the greater depths (8.2 and 11 fathoms) and were least abundant in East Sound. Tomcod were least abundant in winter and spring (I). In an ongoing North Sound study (H), Pacific tomcod (juvenile) were of common occurrence in mud/eelgrass, sand/eelgrass, gravel and cobble habitats (as shown by beach seine) and of common occurrence in rocky/kelp beds (as shown by tow net).

Juvenile Pacific tomcod were taken in most of these habitats in June to November, with none taken in any habitats in February, April and May (H).

In Grays Harbor, tomcod were plentiful in the upper portion of the harbor from May to October (218). A recent Grays Harbor study (G) captured tomcod only during the summer in all deeper harbor areas that were trawled. Although not specifically reported in Willapa Bay (E, F), tomcod probably also occur there. Similarly, they may also occur in the lower Columbia River estuary.

HABITAT REQUIREMENTS - Pacific tomcod use the open water habitat but appear to be bottom-associated in juvenile and adult life stages when not feeding in the water column at night. Eggs and larvae may be pelagic or near the bottom - no information was located. The tomcod is reported abundant during the summer months in coastal harbor and bays and often caught around piers and floats (K). A wide variety of bottom habitats were reported above from a North Sound study (H). The spectrum of bottom types reported (A) for juvenile and adult tomcod includes: eelgrass, silt, sand, "pulpy peat", sand/medium, solid rock, mixed: medium. Pacific tomcod are therefore apparently highly adaptable in their use of bottom types as they occupy a spectrum from silt (mud) to solid rock.

CRITICAL HABITAT AREAS - Pacific tomcod do not appear to have very specific habitat requirements where located to date. Pacific tomcod seem quite well adapted to many different areas. Critical spawning, feeding, nursery-type areas may well exist, but no real specific information exists for this species. An exception may be the coastal bays (Grays Harbor and presumably Willapa Bay) used by tomcod but still little specific information exists on the nature of their use of these two areas.

No critical habitat areas were designated on the basis of the information reviewed.

DATA GAPS - The bulk of the life history of this species is a data gap if sources (A, 166) are representative. The compilation of tomcod catches for the western Strait of Juan de Fuca and coast should be completed. In any areas showing historical concentrations sampling should be started in that season or in areas not sufficiently sampled in the past. Shallow otter trawls in channels and open water (15 to 50 fathoms) in winter, and beach seine, townet, and small trawls in bays in summer should be undertaken. Any spawning concentrations should be tagged and eggs/larvae sought in the vicinity expected on the basis of local oceanographic conditions. With so little information mature tomcod might also be brought to the laboratory for observation of spawning activity, and egg/larvae position in known salinity water. The specific gravity of eggs/larvae should also be ascertained.

Tag recoveries, over a period of years, may indicate the importance of nursery/spawning areas to adjacent waters (i.e., coastal bays to open coast).

REFERENCES - A, C, D, E, F, G, H, I, K, 93, 97, 166, 262, 478, 780.

FACT SHEET

F-22 WALLEYE POLLOCK

Theragra chalcogramma

LIFE HISTORY - The life history of pollock is little studied (166). The walleye pollock is a demersal species (B), well distributed in Washington waters. They are believed to spawn in the winter months in this area (780). Russian studies (B) show a wide spectrum of spawning times (any month of the year) depending on the species location. Late winter seems to fit with the pattern for Asian areas at somewhat higher latitudes (B). In the Bering Sea pollock spawn at 27 to 109 fathoms but can spawn in deeper water (B). The eggs are pelagic (166) and can develop in the water column over bottoms greater than 545 fathoms (B) if currents move them away from shallower waters. Eggs mostly develop in the 0 to 5.5 fathom surface layer (B). Young (4 to 22 mm) were found in the Strait of Georgia at the end of April and in May (166). In the Bering Sea (B) larvae (4 to 9 mm) are primarily in the 5.5 to 13.5 fathom layer of water and not in the surface area. Larger larvae descend deeper and gradually make the transition to the demersal mode of life (B). Metamorphosis to the juvenile stage is complete at 35 mm (B).

Migrations are not reported but may occur. The pelagic early life history of pollock would produce the potential for large movements, although these may be passive, dependent on currents.

Food of young pollock (4 to 22 mm) appears to be totally copepods and their eggs (166). Foods noted in British Columbia studies (166), include shrimp, sand lance, and herring. In Alaska, young pink, chum and coho salmon were eaten and in Asian waters, mysids, euphausiids, silver smelt and capelin were eaten (166).

Walleye pollock grow to 36 inches (166) and are a minor sport and commercial fish species in Washington.

<u>WASHINGTON DISTRIBUTION</u> - The walleye pollock occurs from the surface to 200 fathoms and is suspected of being bathypelagic at 110 fathoms (166). It is generally distributed and common in British Columbia (166) and probably similarly located in Washington waters. Pollock are reported near the bottom in depths over 12.5 fathoms (K).

From catch records of inside waters of Washington, pollock are recorded in 50 or more reports in six of the 12 subdivisions mostly in the general Central and South Sound areas, with the exception of the Strait of Juan de Fuca (C). The actual geographical position of these catch records (D), show scattered records through these inside waters with notable records in channels and open waters (like in the eastern Strait of Juan de Fuca). No comparable records exist for the western Straits or coast.

In a recent North Sound study at East Sound, Guemes Channel, and Cherry Point, walleye pollock were not taken (I) possibly because of the beam trawl used. In an ongoing North Sound study (H), pollock were reported as commonly occurring in the sand/eelgrass and cobble habitats and uncommon in the mud/eelgrass and gravel habitats (as shown by beach seine). Pollock were observed in most of these four habitats in July to December (H).

Walleye pollock were not reported for Grays Harbor (G) and Willapa Bay (E, F).

HABITAT REQUIREMENTS - Walleye pollock are demersal and utilize the open water habitat type through all their life history. Juveniles and adults are bottom-associated in shallow waters and possibly during the day in deeper waters (if diel feeding movements are made by pollock). They are suspected of a bathypelagic existence at 110 fathoms, but are found in waters (near the bottom) to 200 fathoms (166).

Nearshore bottoms used by juveniles include sand/eelgrass, mud/eelgrass, gravel, and cobble (H). Bottom types include: Sand/medium, and silt, in one survey (A). Pollock seem quite adaptable to several bottom types which may indicate their life is spent more off the bottom and not closely associated with any specific substrates.

CRITICAL HABITAT AREAS - Walleye pollock seem quite scattered in inside waters with coastal waters not surveyed in the data reviewed. No critical areas stand out for walleye pollock as they appear well adapted to many areas. A possible critical habitat area may be the shallow surface layer pollock eggs develop in. These would be associated with spawning areas yet to be located. January catches (1935 to 1936) of reproducing adults were made in Whidbey Basin and Strait of Georgia (459).

DATA GAPS - Little is known about this species in Washington waters. Catch records for the western Strait of Juan de Fuca and coast should be summarized and along with sources (C, D) should be surveyed for winter concentrations (January?). These should be resurveyed to look for large spawning concentrations. Unsampled areas should also be sampled if they are thought to have pollock. Once large spawning concentrations are located, tagging should be done, if possible, as well as plankton type studies seeking egg/ larvae. Nearshore shallow areas should be sampled in inside waters with beach seines at those times of the year they were captured in ongoing North Sound studies.

REFERENCES - A, B, C, D, E, F, G, H, I, K, 166, 459, 780.

FACT SHEET

F-23 WOLF-EEL

Anarrhichthys ocellatus

LIFE HISTORY - One survey (A) has "no information stored" for wolf-eel. In British Columbia this species is listed as moderately common in deep waters (166). The family of wolffishes are said to deposit their spawn on the bottom and to have large demersal eggs (M). Some wolffishes lay spherical egg masses which are guarded by one of the parents (N). A female guarded an egg mass in an aquarium until they hatched (166).

Movement of wolf-eels is not reported. They would not be expected to have much movement as they are assumed to be quite sedentary as adults.

Foods include crustaceans, mussels, sea urchins, sand dollars, and fish (373). Walleye pollock are reported as food (166).

The wolf-eel grows to eight feet (166) and is of neither commercial or sport importance in Washington.

WASHINGTON DISTRIBUTION - Wolf-eels are reported to depths of 123 fathoms (British Columbia) and would be expected so distributed in Washington. In catch record summaries (C), wolf-eels are scattered in inside waters with a few reports from most areas. The San Juan Islands area has "10 to 49 reports" while Georgia Strait, Strait of Juan de Fuca, Port Orchard and South Puget Sound have no reports of the wolf-eel (C). The remaining seven subdivisions of inside waters have less than ten reports. The geographical location of these catches shows a few scattered records in the above mentioned areas (D). No similar record exists for the western Straits or coast.

In a recent beam trawl survey of North Sound (I) no wolf-eel were captured as would be expected with this type of gear. In an ongoing North Sound study (H), wolf-eel are reported as occuring uncommonly in rocky/kelp bed habitats (as shown by SCUBA). These were observed in July (H).

Wolf-eels were not reported in recent Grays Harbor (G) or Willapa Bay reports (E, F). Substrate is lacking for these species in these sand/mud bays. Wolf-eels would be expected on the northern coast of Washington where rocky shore and bottomed areas exist.

HABITAT REQUIREMENTS - Little information exists in the data reviewed. They would be expected in open water habitat with a strong bottom-association. One literature survey (A) describes adult wolf-eels on the high intertidal/solid rock/very coarse, in midwater and in the subtidal (bottom-associated) solid rock and boulders. Adults are assumed quite sedentary with possible territories on selected rock/boulder type bottoms that afford some protection for wolf-eels.

CRITICAL HABITAT AREAS - Too little information on wolf-eel life history, and distribution in Washington waters exists to label any possible critical areas. The apparent low numbers of this species (based upon past catch records) raises the question as to the placement of wolf-eels on a "significant" fish species list.

DATA GAPS - Catch records for the western Strait of Juan de Fuca and coast should be completed. This and sources (C, D) should be surveyed and past places of wolf-eel captures should be surveyed by SCUBA methods if depths and visibility allow to look for the abundance, distribution and habitats used by this species.

REFERENCES - A, C, D, E, F, G, H, I, M, N, 166, 373.

FACT SHEET

F-24 <u>PACIFIC OCEAN PERCH</u>

Sebastes alutus

<u>LIFE HISTORY</u> - Pacific ocean perch, like all *Sebastes*, are ovoviviparous, the female is internally fertilized and gives birth to young (166). Life span is reported to be 20 to 25 years (210, 401), and probably limited to 30 years (166). Maturity is reached in six to eight years (21, 401) in this slow-growing species. Fertilization is January-February (21) or earlier (?) with hatching off southwest British Columbia January to March and probably January and February off Oregon (166). Fecundity of female ocean perch is reported from 30,000 to 300,000 fry/female (166, 401). Release of fry is expected near the bottom (401). The young remain pelagic for two to three years (166, 210, 757) and are found offshore to 300 miles (757). The long pelagic life of young ocean perch allows them to range considerable distances offshore from the banks where the adults are found.

Migrations in this young state could be extensive. Adults may also make distant long shore migrations. Ocean perch are known to make seasonal migrations to shallower waters (90 to 170 fathoms, 210; 120 fathoms, 757) and to deeper waters in winter (150 to 200 fathoms, 210; 180 fathoms, 757). Movement to waters 30 to 50 fathoms deeper is reported in winter (781). The summer movement is a spawning migration in which sexes are in separate groups (21). Movement also occurs with age as ocean perch less than ten years are generally in waters shallower than 200 fathoms, while fish 11 to 20 years are in two populations, one in waters less than 200 fathoms, and one in greater depths (781).

Foods are planktonic crustaceans, euphausiids, calanoids coperods, hyperids, mysids, amphipods, and pandalids (21, 210).

The Pacific ocean perch grows to 20 inches (166) and is a major commercial species coming presumably from offshore federal waters. This species ranks first in rockfish landed (J).

WASHINGTON DISTRIBUTION - Pacific ocean perch are mainly offshore at depths from the surface to 350 fathoms, but mainly below 70 fathoms (166). Washington otter trawl fishermen catch this species from 90 to 200 fathoms (J). Most fishing (British Columbia) is between 90 and 160 fathoms (166). In inside waters, the summarized catch records (C, D) show one ocean perch record, west of McArthur Bank in Strait of Juan de Fuca in August, 1960. No similar summary exists for the western Straits where this species is located (348) and on the offshore coast where they are in commercial abundance (J).

No ocean perch were caught in a recent survey at East Sound, Guemes Channel, and Cherry Point (I), nor in an ongoing North Sound study (H). Ocean perch were not reported from coastal bay studies (E, F, G).

HABITAT REQUIREMENTS - The Pacific ocean perch utilizes the open water habitat type, becoming bottom-oriented after two to three years.

The fry and young (to two to three years) are pelagic, occupying midwater areas (A).

The adults are bottom-oriented but are still labeled pelagic and midwater (A). They may make movements up into the water column at night in feeding from their usual position near the bottom.

Bottom substrates are not described (A) but would be expected to be firm bottoms with ledges, submarine canyons, etc. Rocky outcrops may also provide ocean perch habitat.

CRITICAL HABITAT AREAS - No areas were located for ocean perch based on the information reviewed. Ocean perch seem few in number in inside waters and increasing in the western Strait of Juan de Fuca to commercial quantities offshore the Washington Coast. They would appear to have no probable critical areas in Washington waters as the bulk of their life history is spent in waters beyond the three-mile state limit. Although landed commercially from offshore areas, a question arises as to its significance in Washington waters.

DATA GAPS - A catch record summary for the western Strait of Juan de Fuca and coast should be a first effort. From the timing of these catch records, the spacial and temporal distribution of ocean perch could possibly be well defined. Trawling should be completed to confirm concentrations. Early life history (pelagic fry and juveniles) may require midwater sampling in the vicinity of located spawning grounds.

REFERENCES - A, C, D, E, F, G, H, I, J, 21, 34, 166, 210, 401, 757, 781.

FACT SHEET

F-25 SILVERGRAY ROCKFISH (SHORT-SPINE)

Sebastes brevispinis

LIFE HISTORY - One review (A) has "no information stored" for the silvergray rockfish. This rockfish is ovoviviparous, giving birth to live young (fry). The fry are released in late spring or summer off Oregon and in June off Washington (166). The fry and juveniles are presumed pelagic for some time, possibly similar to those of Pacific Ocean perch (F-24).

Migrations and feeding may also be similar to Pacific ocean perch (F-24).

Silvergray rockfish grow to 28 inches (166), and are an important commercial species, ranking fourth in rockfish landings (J).

WASHINGTON DISTRIBUTION - Silvergray rockfish are located in the open coast regions off the west coast of Vancouver Island and Queen Charlotte Sound and from inside waters of British Columbia (166). This rockfish would have the same distribution in Washington but only one record exists for inside Washington waters (C, D). The single specimen was from Carr Inlet, South Sound, in November, 1972 (D). Silvergray rockfish are found from beaches (J) to 200 fathoms (166, J). Information reviewed did not describe the primary commercial trawling grounds. A catch summary does not exist for the western Strait of Juan de Fuca and coast. This species was not reported in coastal bays (E, F, G).

HABITAT REQUIREMENTS - Silvergray rockfish use the open water habitat but become bottom-oriented with age. No specifics on bottom types were located in one survey (A). The bottom type may be that suggested for Pacific ocean perch (F-24).

CRITICAL HABITAT AREAS - No critical areas could be determined from the information reviewed, unless the young of silvergray rockfish utilize shallower (10 to 20 fathom) waters that are in the State and near shore or they are trawled there. Their designation as a significant fish species of Washington (even though fourth ranked in rockfish landings) may be questionable.

DATA GAPS - See species F-24.

REFERENCES - A, C, D, E, F, G, J, 166.

FACT SHEET

F-26 COPPER ROCKFISH

Sebastes caurinus

LIFE HISTORY - The copper rockfish is a shallower water species as compared to Pacific ocean perch (F-24). They also bear their young alive. Time of spawning is after April when most females in Washington are carrying embryos (166). "Summer months" is the reported spawning period (780). Maturity is reached at age 4 (485).

The later life history was not described. Migration information was also not described.

Copper rockfish feed at night and at dawn and are inactive in winter (485). Larger rockfish eat fish primarily - herring (780), while small rockfish eat more shrimp (485). Perches and sculpin are also eaten (485). Crabs and isopods are also reported (780, 945).

The copper rockfish grows to 21.5 inches (166) and is one of the most important bottom fish caught by anglers in Washington (J).

WASHINGTON DISTRIBUTION - Copper rockfish are common in many shallow water areas in British Columbia (166) and are expected to be comparably distributed in Washington. In inside waters, they are the most numerous rockfish reported (C). This summary (C) indicates 50 or more reports in seven of 12 subdivisions, with only Strait of Georgia any copper rockfish records.

The geographical distribution (D) of these catches in inside waters indicates they are scattered throughout the area's shallower waters. No comparable record exists from the western Straits and coast. Abundance is greatest in fall and lowest in spring and summer in Puget Sound (485).

One beam trawl survey of East Sound, Guemes Channel and Cherry Point did not catch copper rockfish (I). An ongoing North Sound Study (H), reports juveniles in common occurrence in the gravel habitat (as shown by beach seine) and adults in the rocky/kelp bed habitat (as shown by SCUBA). Copper rockfish were caught in the first habitat in July to November and seen in the second habitat through most of the year (H). Juvenile copper rockfish were taken March through August in the gravel habitat only (H).

This species was not reported for coastal bays (E, F, G).

HABITAT REQUIREMENTS - Copper rockfish use the open water habitat but are bottom-associated as juveniles and adults. Juveniles are reported as pelagic in Queen Charlotte Sound (511). Older juveniles and adults in shallow waters are associated with rocky bottoms (J, K). They are often found in shallow water around rocks, kelp, or pilings during the summer, but are most frequently taken from depths over 8.3 fathoms (50 feet) (K). Gravel and rocky/kelp bed habitats are reported in North Sound (H). Substrates in one survey (A) includes eelgrass, solid rock, silt, sand: medium, boulder, and mixed: fine. These various substrates indicate the copper rockfish is quite adaptable.

The copper rockfish is also reported around rockpiles in sand areas and occasionally in kelp beds in the summer (485, 780).

CRITICAL HABITAT AREAS - Copper rockfish seem well distributed and well adapted to many bottom types. No feeding or spawning concentrations were located. No critical areas were designated for this species.

DATA GAPS - Catch records for the western Strait of Juan de Fuca and coast (particularly the northern half) should be summarized and used with sources (C, D) to define possible areas of concentration. These should be resurveyed using SCUBA (if depths and visibility allows) or nets suited to the area's substrate. Early life history studies on pelagic fry and juveniles could begin as spawning concentrations are located (if they occur). Tagging would be of interest to see to what degree adults migrate.

REFERENCES - A, C, D, E, F, G, H, I,J, K, 166, 485, 511, 780, 945.

FACT SHEET

F-27 PUGET SOUND ROCKFISH

Sebastes emphaeus

LIFE HISTORY - One survey has "no information stored" (A). Another source (166) has no section on life history. One source (W) provides all the life history information located:

> Spawning females were located in the San Juan Island vicinity in August and September -- the latest maturing *Sebastes* in this region. Fecundity ranged from 20,177 to 57,103. Age at maturity ranged from two to four years.

WASHINGTON DISTRIBUTION - This rockfish is known mainly for deep water in Puget Sound and San Juan area of Washington (166). Fewer than ten reports of Puget Sound rockfish are reported for San Juan Islands, Everett area and Seattle area (C). The actual geographical distribution of records of this species (D) show seven records from the San Juans and five from the Edmonds Oil Dock area (Seattle area) in a diver's log. The remainder are scattered single records from general Puget Sound, Everett area, and Admiralty Inlet (D).

A newer report (W) indicates a more shallow water existence for the Puget Sound rockfish (about 5 to greater than 15 fathoms) at least in the San Juan Island vicinity from June to October. In this period large concentrations of adult fish at three locations in the San Juan Channel: Cantilever Pier, Shady Cove, and Turn Island (W).

Rockfish were not taken in a recent survey of East Sound, Guemes Channel and Cherry Point (I). In an ongoing study in North Sound (H), Puget Sound rockfish were reported as commonly occurring in the rocky/kelp bed habitat (as shown by SCUBA). At Point George (Shaw Island) this species was seen in this habitat in the winter (December-February) (H). This species was not reported in coastal bay studies (E, F, G).

HABITAT REQUIREMENTS - The Puget Sound rockfish was originally reported as a deeper water species, yet more recent studies place the species for most of the year at least in "SCUBA depth", about 5 to greater than 15 fathoms (W). In the North Sound studies (H), this rockfish was in the rocky/kelp bed habitat in December through February (H). In the San Juan Island vicinity this rockfish appeared in areas with strong currents, steep rocky slopes and caves and crevices in rock piles (W).

The habitat in deeper waters is not described, but they would be expected over rough rocky bottoms similar to those areas in shallow waters.

The Puget Sound rockfish thus utilizes the open water habitat type, but is apparently bottom associated from birth through adulthood.

CRITICAL HABITAT AREAS - The San Juan Islands have the largest numbers of Puget Sound rockfish according to SCUBA observations presented in two sources (H, W) for the San Juan Channel vicinity. No Puget Sound rockfish were seen at Barnes Island and Allan Island in Rosario Strait, even though the same type (rocky/kelp bed) of habitat was surveyed (H).

Many more rocky/kelp bed sites in the San Juan Island group would need to be surveyed to conclude which, if any, specific areas in this island group is critical for this species. No critical areas are designated for Puget Sound rockfish based on the information reviewed.

DATA GAPS - Little is reported for this species life history and little is known about its abundance distribution and habitat requirements. A catch summary should first be completed for the western Strait of Juan de Fuca and the coast. For this species, no records are expected from these areas. Using any new catch records and sources (D, H), surveys by SCUBA should be completed quarterly on suitable rocky/kelp bed habitats in San Juan Islands area, Everett area, Seattle area, and Admiralty Inlet area.

If this species is in the low abundance indicated by existing catch or observation records, its importance could be considered from two opposing views: (1) It is rare and should be treated as "rare and endangered", or (2) It is in insufficient numbers to be considered a "significant" species in the waters of Washington. Because the species is apparently restricted to Puget Sound based upon its "distribution" (166) the first option should be considered. Critical areas may therefore be everywhere the species is located if it is in low abundance throughout its limited range.

Where observed, early life history studies and tagging should be undertaken to find out more about this early life period and movements of this species. Any fish killed in sampling should be the subject of stomach analysis for diet information.

REFERENCES - A, C, D, E, F, G, H, I, 166.

FACT SHEET

F-28 YELLOWTAIL ROCKFISH

Sebastes flavidus

LIFE HISTORY - Little information exists for yellowtail rockfish. This rockfish bears live young as do other *Sebastes*. Life span is long - 24 years - and maturity is reached in five to six years (487). Fecundity is as great as 633,000 eggs/female (487). Young are born in January and February off Oregon and March off British Columbia (166). So they probably are born in Washington during this period. The remainder of their life history was not reported in the information reviewed but this would be expected to be similar to other rockfishes (F-24 and F-25).

Migrations are not reported. They have been found to eat in one locality mainly on smallfin lanternfish with lesser quantities of crustaceans and squid (166).

The yellowtail rockfish grows to 26 inches (166) and is important as both a sport and commercial species - ranks second in commercial rockfish landings (J).

WASHINGTON DISTRIBUTION - The yellowtail rockfish is reported to 300 fathoms and generally distributed in British Columbia (166). In inside waters of Washington 50 or more reports of this species have only occurred in Colvos Passage with no reports from Georgia Strait, Everett area, Admiralty Inlet, Central Puget Sound, and Port Orchard (C). The geographical distribution of these records shows records in Colvos Passage and off Seattle (D). Offshore catches in the Strait of Juan de Fuca and Ediz Hook and Dungeness Spit are also of interest. No comparable summary exists for the western Straits and coast.

No rockfish were taken in recent beam trawl surveys at Cherry Point, Guemes Channel, and East Sound (I). In an ongoing North Sound Study (H), juveniles were in common occurrence in gravel habitat (as shown by beach seine) and adults in rocky/kelp bed habitat (as shown by SCUBA). This rockfish was seen in the gravel habitat only in September while rocky/kelp bed habitat observations were in most of the year (H).

Yellowtail rockfish were not taken in coastal bays (G, E, F). They are reported to occur sporadically in coastal bays (inside waters?) (K).

This species is the second most abundant rockfish commercially taken (behind Pacific ocean perch) in Washington (J). They are more common in ocean catches from offshore waters (K).

HABITAT REQUIREMENTS - Yellowtail rockfish utilize the open water habitat particularly in the early stages of life when they are presumed to be pelagic. The juvenile through adult stages become bottom-oriented. This species is reported to form schools off the bottom (166). However, it is caught by both trawls and troll gear (J), indicating movements up into the water column. They are reported as either on the bottom or near the surface (K). The bottom type reported is very coarse (A).

CRITICAL HABITAT AREAS - No critical habitat areas stand out from the data reviwed. Catch information from the area of greatest abundance in coastal Washington and offshore would need to be summarized and additional studies completed for yellowtail rockfish where these catch records and sources (C, D) show them to be concentrated.

DATA GAPS - Little is reported on this species' life history. A study plan described for Pacific ocean perch (F-24) applies also to this species.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 166, 487.

FACT SHEET

F-29 BLACK ROCKFISH

Sebastes melanops

LIFE HISTORY - Little information was located for black rockfish. Young are born alive as in all *Sebastes*. Young are born in British Columbia, mainly in April (166). Summer spawning is reported for Hood Canal (780). A spent female was taken far offshore in February (166). The remainder of the life history was not described. Pelagic young are presumed with an increasing bottom-orientation with age.

Migration to deeper water during late fall to early spring is thought to occur (K). Food of black rockfish includes fish (herring) and invertebrates, especially crabs (780).

Black rockfish grow to 23.25 inches (166) and are a minor commercial species and more important as a sport species in Washington.

WASHINGTON DISTRIBUTION - Black rockfish are reported to 200 fathoms but are most common in British Columbia waters in the 100 to 150 fathom zone (166). They are reported to be widely distributed along the British Columbia coast and found among rocks (166). Black rockfish are reported in inside waters in 50 or more reports at only one location (Colvos Passage) (C). Only Georgia Strait and South Puget Sound lack records in the 12 subdivisions (C). The geographical location of the black rockfish records also shows records grouped at the following places: Edmonds Point, Appletree Cove, south of the west end of Deception Pass, and Friday Harbor (D). Friday Harbor catches are dated June to August (D), which may be when the fish and/or the students are there. A comparable record does not exist for the western Straits and coast. Rockfish were not taken in a beam trawl survey of East Sound, Guemes Channel and Cherry Point (I).

In an ongoing North Sound study (H), juveniles were reported as commonly occurring in the gravel habitat (as shown by beach seine) and as adults in the rocky/kelp bed (as shown by SCUBA). Trammel net catches indicated an uncommon occurrence in the rocky/kelp bed habitat (H). Juveniles were caught in the gravel habitat in July through November and were seen or caught in the rocky/kelp bed habitat through most of the year (H).

In a recent Grays Harbor study (G), black rockfish were captured. "Juvenile rockfish" were absent at some stations but were reported common at the Outer Harbor (as shown by otter trawl) and uncommon at Whitcomb Flats and North Channel in the period June through September (G). They were not reported for the period October through May (G).

Rockfishes (undefined) are said to use Willapa Bay as a nursery area (E), and because black rockfish is the only species reported for Grays Harbor, they may be the species referred to.

HABITAT REQUIREMENTS - Black rockfish are reported found "among rocks" (166) and are common in Washington along rocky shore areas and frequently taken by trolling gear and hand lines (J). Black rockfish are abundant during summer in shallow waters along the rocky kelp-lined shores of the outer coast, apparently retreating to deeper water during late fall through early spring (K).

They are assumed to use the open water habitat particularly when pelagic young are present and when juveniles and adults are away from the bottom and feeding in the water column. Large schools of black rockfish have been observed feeding on the surface (K). They apparently favor moving foods and are thought attracted to light (K).

As juveniles and adults they are bottom-associated in gravel and rocky/kelp bed habitats (H). Other bottom types were solid rock/very coarse, eelgrass and solid rock (A).

Rock/kelp beds (all year) and gravel (July through November) habitats (H) appear important for this species when in shallow waters. When in deeper waters, rocky bottoms, outcropping and reefs may be important bottom types.

CRITICAL HABITAT AREAS - While concentations are reported in the inside waters of Washington, (C, D) they are apparently abundant along the rocky kelp-lined shores of the outer coast (and possibly the western Strait of Juan de Fuca). The summer concentrations in shallow water may be spawning activity or feeding activity or both. At this time, not enough is known about this species' life history to say much about critical habitats required for life history activities. No areas are designated for black rockfish.

DATA GAPS - A first step in understanding black rockfish would be to summarize the catch records for the western Staits and coast of Washington. With this and sources (C, D), concentrations should be resampled using SCUBA (if depth and visibility allow) or hook/line and possibly gill/trammel nets, if bottom type permits. Any confirmed concentrations should be studied to determine if they are feeding, spawning, etc. Large concentrations should be tagged and followed after April-summer months spawning of young, to see where they are located. SCUBA and plankton type nets may be useful in this early life history evaluation.

<u>REFERENCES</u> - A, C, D, E, G, H, I, J, K, 166, 780.

FACT SHEET

F-30 BOCACCIO

Sebastes paucispinis

LIFE HISTORY - The bocaccio is one of the larger local rockfish (to 36 inches and exceeds 20 pounds, J). The bocaccio bears live young like other *Sebastes*. Life span is 30 years, with maturity at three to five years (487). Fecundity is as great as 2.3 million young/female (487). Pacific Northwest spawning is reported in December and April (A), apparently extrapolated from November and March dates in California. Newly released larvae occupy the upper mixed layer of water and as juveniles (30 mm) they move into shallow waters for their first year (166). All life history information is from California and may not be completely applicable in Washington.

Migrations are not mentioned. Food of young bocaccio include small fish (rockfish, perches, and jack mackerel) while older bocaccio eat rockfish, sablefish, squid, anchovies, and myctophids (166, 487).

The bocaccio grows to 36 inches (166) and is both important as a commercial and a sport species.

WASHINGTON DISTRIBUTION - Off British Columbia bocaccio are found most commonly below 40 fathoms and are well regarded as a sport fish in Howe Sound (166). In Washington it is fished commercially at 40 fathoms and also taken as a sport fish (J).

In inside waters, bocaccio are reported in Colvos Passage with 50 or more reports and not reported in South Puget Sound, San Juan Islands, and Georgia Strait (C). In the geographical records of bocaccio catches two areas -- Colvos Passage and Appletree Cove -- stand out. Coastal Washington must have the bulk of Washington's bocaccio population as this species "makes up a significant percentage of Washington groundfish landings" (J). No catch summary exists for the western Strait of Juan de Fuca or coast.

Bocaccio were not taken in a recent (I) and an ongoing (H) North Sound study. They were also specifically not reported for Grays Harbor (G) or Willapa Bay (E).

HABITAT REQUIREMENTS - No information was located on their habitat requirements. They utilize the open water habitat as pelagic young in the water column. They are bottom-oriented (after 30 mm in California) spending a year in shallow water. No bottom types are given, but on the coast where Washington trawlers catch about a million pounds per year (J), they must be over fairly flat bottom, probably of rock or boulder substrate. The depth of 40 fathoms seems preferred by adult bocaccio.

CRITICAL HABITAT AREAS - The habitat requirement of bocaccio is speculative and therefore critical habitat areas are not definable. Catch record summaries for the coast may point to concentrations of bocaccio.

DATA GAPS - Nothing is known from the sources reviewed about the bocaccio's life history in Washington. Hopefully, the species is similar to those in its southern range. A first step would be to summarize records of bocaccio for the western Strait of Juan de Fuca and coast. Once concentrations were located, along with those indicated in sources (C, D), sampling could proceed as described for earlier rockfishes (F-24). SCUBA may be appropriate where and when they are in shallow waters; trawling would seem appropriate off the coast.

<u>REFERENCES</u> - A, C, D, E, G, H, I, J, 166, 487.

FACT SHEET

F-31 YELLOWEYE ROCKFISH (RED SNAPPER)

Sebastes ruberrimus

LIFE HISTORY - Little information is available for this species. Yelloweye rockfish are a large rockfish species (K) with a fecundity of 2.7 million fry/female (166). Like other *Sebastes*, they are ovoviviparous, giving birth to live young (166). In Washington young are born in June (166). The life history stages following were not described.

Migrations were also not described in the sources reviewed. Yelloweye rockfish are known to eat crustaceans and lingcod spawn (166).

The yelloweye rockfish grows to 36 inches (166) and is both an important commercial and sport species in Washington.

WASHINGTON DISTRIBUTION - Yelloweye rockfish are generally distributed in waters from 25 to 300 fathoms (166). They are reported throughout coastal British Columbia around reefs in both inside and outside waters (166).

Records of yelloweye rockfish catches in inside Washington waters (C) indicate few or no records in most of the study subdivisions. Records of 50 or more are reported only for the San Juan Islands, while Admiralty Inlet, Central Puget Sound, Seattle area, and Colvos Passage have no records of this species (C). The Bellingham area and Hood Canal have 10 to 40 records (C).

The geographical location of these yelloweye rockfish (D) shows two record concentration areas -- Central Bellingham Bay and Sucia Island (east, west and south sides). No comparable record exists for the western Strait of Juan de Fuca and coast.

This rockfish was not taken in recent North Sound Studies (H, I), nor was it specifically reported for coastal bays (E, F, G).

The species occurs on the outer coast, usually in depths greater than 25 fathoms (K), probably along the rocky northern part of the Washington coast. This species uses the open water habitat but is bottom-associated.

HABITAT REQUIREMENTS - Yelloweye rockfish (adults) occur around reefs in waters usually over 25 fathoms. They are usually not taken by trawls (166) indicating a rough bottom habitat. They are taken on setlines (166, J) fished in the vicinity of rocky banks (J). The lingcod spawn as food also indicates a use of shallow water reefs. The species (adults?) is reported always near the bottom (K) in the open water habitat.

CRITICAL HABITAT AREAS - Very little information was located about this rockfish's life history, distribution and abundance. In general, the yelloweye rockfish is not abundant in inside waters according to historical records (C, D), but may be more common on the outer north coast. Too little information exists for this species, although catch concentrations (D) near Sucia Island and Bellingham Bay are of interest. Too little information exists about this species' life history to say how critical these two areas may be.

No areas were defined based upon the information reviewed.

DATA GAPS - The life history of this species is little understood. As a first step summaries of catch records should be completed for the western Straits and coastal Washington. With this and sources (C, D) existing concentrations of yelloweye rockfish should be resampled using gear types and methods described for F-29 with the addition of setlines as a sampling tool.

REFERENCES - C, D, E, F, G, H, I, J, K, 166.

FACT SHEET

F-32 CANARY ROCKFISH (ORANGE)

Sebastes pinniger

LIFE HISTORY - The canary rockfish has a life span of 22 years and matures at five to six years (487). Like all *Sebastes*, young are born alive. Fecundity is reported from 260,000 to 1.9 million young/female, depending on size (487). Birth occurs in January or later off British Columbia (166). None of the life history stages following were described.

Migrations were not reported in the information reviewed. Foods of canary rockfish (adults) includes euphausiids, anchovies, and sanddabs (487).

The canary rockfish grows to 30 inches (166) and is both an important commercial and sport species in Washington.

WASHINGTON DISTRIBUTION - Canary rockfish occurs to nearly 200 fathoms but is encountered (British Columbia) at depths from 50 to 100 fathoms (166). They are reported near the bottom in depths over 25 fathoms in Washington waters (K). In a catch record summary (C) of inside waters, this rockfish is reported in 50 or more reports only in Colvos Passage and in 10 to 49 reports in Hood Canal and San Juan Islands. Georgia Strait, Bellingham area, Central Puget Sound, and Port Orchard have no records for this species (C). The geographical record of these catches (D) shows these concentrations with the remaining catches scattered. No comparable records exist for the western Straits and coast of Washington.

This rockfish was not caught in recent shallow water (I) and nearshore (H) North Sound studies. This species was also not specifically reported in coastal bay studies (G, E, F).

HABITAT REQUIREMENTS - Canary rockfish utilize the open water habitat but become bottom-associated presumably in the late juvenile stage and through their adult life. They are found near the bottom and are not restricted to rocky bottoms (K). They are taken with otter trawls (J), also indicating a moderately smooth bottom. They are reported over hard bottoms (166). No bottom types are referenced in one survey (A).

CRITICAL HABITAT AREAS - Little life history, distribution and habitat information was located for canary rockfish. Therefore, no critical areas can be designated.

DATA GAPS - A first step should be to summarize catch records for canary rockfish in the western Strait of Juan de Fuca and coast. From this summary and other sources (C, D) areas of concentration in late winter and early spring should be resampled seeking major spawning areas (if they exist). Other concentration sites and areas with appropriate depth and bottom and little or no past effort, should be resampled by trawl. Plankton type nets should be utilized in midwater searches for pelagic fry in the vicinity of any located spawning areas. Tagging (if possible) would also be of interest to see where adults move with the seasons.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 166, 487.

FACT SHEET

F-33 CHILIPEPPER

Sebastes goodei

LIFE HISTORY - Little life history for chilipepper rockfish was found in the sources reviewed. Like all *Sebastes*, they give birth to live young. Life span is 16 years (487). They mature at four years (166), three to five years (487). Fecundity is reported from 29,000 to 538,000 young/female (487). Fry are presumed to be in the midwater with juveniles and adults becoming bottom-oriented.

No movement information was located. Food is reported as euphausiids and small fishes (anchovies, lanternfish, and young hake) (166).

The chilipepper grows to 21.2 inches (166) and is not presently of commercial importance in Washington.

WASHINGTON DISTRIBUTION - The northern limit of this species is Cape Scott (Vancouver Island) with only one record from British Columbia (166). Depths of 180 fathoms are noted (166). They are not reported for inside Washington waters (C, D) or in recent North Sound studies (H, I). They are also not described in two general marine fish publications (J, K) for Washington. They were reported uncommon in the western Strait of Juan de Fuca (370) and as a "few" on the open coast in 100 to 167 fathoms (258).

HABITAT REQUIREMENTS - This species presumably uses the open water habitat and becomes bottom-associated after a pelagic fry state. The bottom type it is associated with is not described (A).

CRITICAL HABITAT REQUIREMENTS - None can be described from the little data located. A basic question exists as to why this species should be on a significant fish species list in Washington.

DATA GAPS - See F-24 if research is to be carried out on this species.

REFERENCES - A, C, D, H, I, J, K, 166, 258, 370, 487.

FACT SHEET

F-34 REDBANDED ROCKFISH (FLAG)

Sebastes babcocki

LIFE HISTORY - Little is known about this species. Like all *Sebastes* it is ovoviviparous, giving birth to live young. Off British Columbia half of the males are mature at 38 cm and half of the females at 42 cm (166). No ages are given but this probably is from four to six years of age. Off Oregon redbanded rockfish probably give birth in April and May and in British Columbia in April (166). No additional life history information was given in sources located. Fry are assumed pelagic with an increasing bottom association with age.

Migrations were not reported in sources reviewed. A literature search (A) on food of redbanded rockfish had "no information stored".

The redbanded rockfish grows to 25 inches (166) and is a minor commercial species in Washington.

WASHINGTON DISTRIBUTION - In British Columbia this rockfish is located in open waters from the west coast of Vancouver Island to Dixon entrance, Queen Charlotte Sound, Hecate Strait (166). This species is found in waters 50 to 240 fathoms (166). In inside Washington waters, only two records exist, one from Friday Harbor, San Juan Islands, and one from near Hoodsport, Hood Canal (C, D). No comparable record exists for the western Strait of Juan de Fuca and coast.

North Sound studies (H, I) do not record this species. Coastal bay studies (G, E, F) do not report this species. Commercial (J) and sport (K) fishing publications do not discuss this species in Washington.

Other than the British Columbia reference (166), the literature survey (A) reports no redbanded rockfish in Washington.

HABITAT REQUIREMENTS - No data was located for this species. A guess would be that they are open water habitat users with a pelagic fry state followed by an increasing bottom association through the juvenile and adult stages. The bottom type could be speculated as rock in the Friday Harbor record and mixed coarse in the Hoodsport record. The absence of this species from a commercial fishes report (J) may mean they are in low abundance on the coast or possibly over rough untrawlable bottom.

CRITICAL HABITAT AREAS - The general habitat requirements of redbanded rockfish can not be defined, much less critical areas. If the abundance of this species off the Washington coast is as low as expected from the sources reviewed, a question ramains as to why this rockfish is on a significant marine fish list for Washington.

DATA GAPS - The numbers of this rockfish in Washington waters appears too low to require any research directed specifically at this species.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 166.

FACT SHEET

F-35 ROUGHEYE ROCKFISH

Sebastes aleutianus

LIFE HISTORY - Little is reported for this species. The rougheye rockfish is ovoviviparous, giving birth to live young. Life span, age of maturity and fecundity were not reported in sources reviewed. Principal spawning off British Columbia is in April (166). Pelagic fry, with an increasing bottom association with age, is presumed for this species. Migration and foods of rougheye rockfish are not reported (A).

The rogheye rockfish grows to 38 inches (166) and is a minor commercial species in Washington.

WASHINGTON DISTRIBUTION - Rougheye rockfish are reported common in offshore waters, but rare inshore in British Columbia (166). Depths for this species range from 50 to 400 fathoms (166). In inside Washington waters, only four records exist for this species (C, D) -- two in "Puget Sound", one in the San Juans and one in the Everett area. No comparable catch record exists for the western Strait of Juan de Fuca and coast.

On the open coast (of Washington?) rougheye rockfish are reported bottom-associated and present in 50 to 400 fathoms (258) and common on the Washington coast, pelagic/bottom-oriented at depths greater than 200 fathoms (757). Rougheye rockfish are also reported as present in the Strait of Juan de Fuca in all months (370).

This species was not taken in North Sound studies (H, I) or in coastal bay studies (E, F, G). Two papers dealing with commercial (J) and sport (K) marine fishes do not discuss this species.

HABITAT REQUIREMENTS - Little information was located. This rockfish is presumed to use the open water habitat type as pelagic fry and becoming more bottom-associated with age. Bottom types as juveniles and adults are expected to be hard rocky bottoms, possibly rough rock outcrops or submarine reefs.

CRITICAL HABITAT AREAS - The general habitat requirements were not definable from sources reviewed, much less any critical areas. Unless some abundances of this species are confirmed in outside waters and the western Strait of Juan de Fuca, a question exists as to the significance of this species in Washington.

DATA GAPS - A first step would be to summarize the western Straits and the open coast catches of rougheye rockfish and with sources (C, D) proceed to resurvey areas of concentration around April, looking for spawning concentrations (if they exist). From there the plan described for Pacific Ocean perch (F-24) would follow. Again, unless greater numbers are reported elsewhere, specific research on this species may not be warranted.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 166, 258, 370 757.

FACT SHEET

F-36 SPLITNOSE ROCKFISH

Sebastes diploproa

LIFE HISTORY - The splitnose rockfish, like all *Sebastes*, gives birth to live young. Life span is 18 years (487). Spawning is reported in late spring off British Columbia and Oregon (166) and presumably also for Washington. Half the splitnose rockfish are mature at 21 cm (five years) in California, whereas off British Columbia the size at maturity is 27 cm (166) or five to six years (487). Fecundity ranges from 14,000 to 255,000 fry/female depending on size (487).

Migrations were not reported in sources reviewed. Foods of adults are euphausiids (487).

The splitnose rockfish reaches a length of 18 inches and is a minor commercial species in Washington.

WASHINGTON DISTRIBUTION - British Columbia records are from the Strait of Georgia and the west coast of Vancouver Island (166). Depths range from 50 to 316 fathoms (166). Inside Washington waters have few records of splitnose rockfish with seven fish from Hood Canal and one from Central Sound (off Port Madison) and one from the San Juans, (C, D). The seven records in Hood Canal are scattered from the central point to the Big Bend of the Canal (D). No comparable records exist for the western Strait of Juan de Fuca and coast.

The splitnose rockfish was not reported in recent North Sound studies (H, I) or in coastal bay studies (G, E, F). This species is not described in popular commercial (J) and sport (K) fish publications.

This species is described as present in all months in pelagic/ bottom-oriented habitats of the open coast (462, 370) and the Strait of Juan de Fuca (373). It is also reported common at 50 to 300 fathoms on the open coast (258).

In the San Juans, a report (292) indicates this species is present in 40 fathoms at Harney Channel in June. This is close to the single Upright Channel catch location (D).

HABITAT REQUIREMENTS - Little specific information was located. Splitnose rockfish use the open water habitat with a presumed pelagic fry that become bottom-oriented through the juvenile and adult stages. The bottom types are not described in one survey (A) but is presumed to be the rock or mixed coarse type.

CRITICAL HABITAT AREAS - The general habitat requirements of splitnose rockfish can not be defined from sources reviewed, much less any critical areas.

DATA GAPS - A first step would be the compilation of this species' catch records in the western Strait of Juan de Fuca and coast. If the species is more numerous than this review has indicated, then the procedures described for Pacific Ocean perch (F-24) should be followed. If the species is as scarce as indicated by this review, a question remains as to why it should remain on a significant marine fisheries list, and no specific research should be directed towards this species.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 166, 258, 292, 370, 373, 462, 487.

FACT SHEET

F-37 GREENSTRIPED ROCKFISH

Sebastes elongatus

LIFE HISTORY - The greenstriped rockfish occupies a wide range of depths from piling areas (780) to 200 fathoms (166). Little information exists on the species life history. Life span, age of maturity, and fecundity were not reported. Like all *Sebastes*, live young are born. Young are probably born in late spring or early summer off Oregon, Washington and British Columbia (166). No other life history was reported. Fry are assumed pelagic with increasing bottom association with age.

Migrations are not reported. Food includes herring and invertebrates, especially crabs (780).

Greenstriped rockfish grows to 15 inches (166) and is a minor commercial species in Washington.

WASHINGTON DISTRIBUTION - In British Columbia, this species is most commonly found at depths of 50 to 200 fathoms in both inshore and offshore waters (166). They are fairly common in the Strait of Georgia (166). In inside Washington waters, catch summaries for greenstriped rockfish indicate few records with only Hood Canal having 10 to 49 reports (C). Georgia Strait (in Washington), Bellingham area, Admiralty Inlet, Port Orchard and Colvos Passage, have no records of this species (C). The actual geographical distribution shows scattered records in all but the five subdivisions without records (D). No comparable record exists for the western Straits and coast.

This species was not taken in recent North Sound studies (H, I) or in coastal bay studies (G, E, F). Two popular commercial (J) and sport (K) publications do not report on this species in Washington.

This species is reported present in the Straits of Juan de Fuca and Georgia (370, 373) and common (258) and present (462) on the open coast. A few are reported in Admiralty Inlet (970). One is reported off West Point in April (507). They are also reported abundant in Bangor area (780). These reports update the catch summary (D) and represent newer records. Views appear to conflict between few and abundant in Puget Sound (A).

HABITAT REQUIREMENTS - Greenstriped rockfish are presumed to use the open water habitat as pelagic fry and become more bottom-oriented with age. Water depths of 50 and 200 fathoms are used in both inside and outside waters (166).

The only substrate mentioned in one survey (A) is sand/medium for the single fish from West Point. The Hood Canal records may also be over sand, but could also include rock, mixed-fine and mixed-coarse bottom types.

CRITICAL HABITAT AREAS - Too little information exists to describe general requirements, much less critical areas. Hood canal (Bangor area to the Big Bend) appears to be the main area for this species in inside waters, but they are scattered elsewhere. No areas can be designated from the information reviewed.

DATA GAPS - Little is known about this species. A first step would be the western Strait of Juan de Fuca and coast catch summary with surveys of concentrations following the plan suggested for Pacific ocean perch (F-24). If this species is, in fact, as scarce as some sources indicate, a question remains as to why it is considered a significant marine fish in Washington.

<u>REFERENCES</u> - A, C, D, E, F, G, H, I, J, K, 166, 258, 370, 373, 462, 507, 780, 970.

FACT SHEET

F-38 BROWN ROCKFISH

Sebastes auriculatus

LIFE HISTORY - The brown rockfish has little life history information in the sources reviewed. As in all *Sebastes*, live young are born. Life span and age at maturity were not described. Fecundity is known from 52,000 to 339,000 young/female dependent on size (166). Most Puget Sound females are carrying young in May and probably give birth in June (166). Fry are assumed pelagic with an increasing bottom-orientation with age.

Migrations and food habits are not reported.

Brown rockfish grow to 20.5 inches (166), are probably a minor sport species in Washington.

WASHINGTON DISTRIBUTION - Brown rockfish are not commonly observed in British Columbia but are probably sparsely distributed in shallow water (166). They are "well known" in Puget Sound (166). They are recorded in catch summaries (C) from Everett and south in Puget Sound and Hood Canal. Port Orchard is the only area with 10 to 49 reports while Georgia Strait, Strait of Juan de Fuca, San Juan Islands, Bellingham area, and Colvos Passage have no reports (C). The geographical record (D) of these catches shows records scattered (in areas with records) except for Port Orchard and areas off Alki and West Points near Seattle. No comparable record exists for the western Strait of Juan de Fuca and coast.

One recent North Sound beam trawl survey did not catch these rockfish (I). In an ongoing North Sound study, brown rockfish were reported as an uncommon occurrence in the gravel habitat, as shown by beach seines (H). The only catches were in May (H).

This species was not reported in coastal bays (G, E, F).

<u>HABITAT REQUIREMENTS</u> - Shallow waters are utilized by this species (166). This species is assumed to utilize the open water habitat as pelagic fry and become more bottom-associated with age. Bottom types reported include sand/medium in one 25 fathom catch (A) and gravel in shallow catches (H). No other bottom types are mentioned. This species may utilize less rock and more sand/gravel type bottom than some other rockfish.

<u>CRITICAL HABITAT AREAS</u> - Too little is known about this species' life history and general habitat requirements to say much about critical areas. Concentrations (possibly from an excessive sampling effort over other areas) appear in Port Orchard and off Seattle (West and Alki Points) but too little information exists on what this species may be doing there (feeding, reproduction, etc.). No areas are designated from the information reviewed.

<u>DATA GAPS</u> - Very little is reported about brown rockfish. A first step would be the summarization of brown rockfish catches in the western Strait of Juan de Fuca and coast to complement other sources (C, D). From these sources, concentrations should be resampled and procedures followed those described for shallow water rockfish (F-29). If low abundances of brown rockfish exist in the western Straits and coast, and if numbers are not greater than apparent from inside waters (C, D), this species may be a candidate for removal from the significant species list.

<u>REFERENCES</u> - A, C, D, E, F, G, H, I, 166.

FACT SHEET

F-39 <u>REDSTRIPE ROCKFISH</u>

Sebastes proriger

<u>LIFE HISTORY</u> - The literature survey (A) has no information stored for any component of the redstripe rockfish life history, distribution or abundance. Another major source (166) lacks a "life history" section for this species. Without information, one can only state that this rockfish is like others and is ovoviviparous, giving birth to live young. One can speculate that fry are pelagic and juveniles and adults become more bottom-oriented. No information on food habits or migration was located.

The redstripe rockfish grows to 24 inches (166) and is a minor commercial species in Washington.

<u>WASHINGTON DISTRIBUTION</u> - The redstripe rockfish is distributed through Washington at depths ranging from 50 to 200 fathoms (166). This rockfish is generally distributed in coastal British Columbia (166). In inside Washington waters only one area has 10 to 49 reports of redstripe rockfish -- Hood Canal (C). The following areas have no reports -- Georgia Strait, Strait of Juan de Fuca, Admiralty Inlet, Port Orchard, Colvos Passage and South Puget Sound (C). With relatively few records in inside waters, the geographical summary of catches shows scattered reports (D). No comparable record exists for the western Strait of Juan de Fuca and coast.

This species was not reported in recent North Sound studies (H, I) or in coastal bay studies (G, E, F). This species is not reported in Washington commercial (J) and sport (K) publications.

HABITAT REQUIREMENTS - This rockfish uses the open water habitat with fry presumed pelagic. An increasing bottom association is presumed to occur with age. Bottom types are not reported (A) but the catch record (D) suggests harder bottoms -- gravel to rock bottoms.

CRITICAL HABITAT AREAS - No areas can be defined because the general habitat cannot be described. If outside waters have few or no redstripe rockfish reports, this species may also be a candidate for removal from a significant fish species list for Washington.

DATA GAPS - Next to nothing is reported for the redstripe rockfish. A first step would be a catch record summary for the western Strait of Juan de Fuca and coast to complement other sources (C, D). If reports are few, this specific research on this species may not be warranted. If reports are many, the study suggestions made for other rockfish (F-24, F-29) could be followed.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 166.

FACT SHEET

F-40 BIG SKATE

Raja binoculata

LIFE HISTORY - The big skate is a common skate species at moderate depths. Like all skates, egg are fertilized internally and expelled in horny egg cases (166). The skate can copulate and lay eggs (in cases) at any time during the year (780). The egg cases are large -- up to a foot long and contain up to seven eggs (166). Egg cases have been found in recognizable beds with embryos in various stages of development (166). Egg cases are usually laid near shore in shallow sand or mud beds to incubate up to 15 months (272). The young emerge from the egg cases closely resembling the adults (K). The young are caught in shallow waters (H) and are presumed to use these waters as nursery areas. With age, big skate juveniles would be expected to move to the moderate depths they inhabit as adults.

Migrations are not reported. Foods include bottom dwelling invertebrates (crustaceans) and small and large fish (such as great sculpin; 166, 373, 780).

The big skate grows to a length of eight feet (166) and occurs in sport and commercial catches in Washington.

WASHINGTON DISTRIBUTION - Big skate are reported common throughout British Columbia at moderate depths (166) and are presumed similarly distributed in Washington. Little specific data is reported in the literature survey (A) where *Raja sp.* are apparently reported in the bulk of the available information.

In inside waters, the catch record summary (C) has 10 to 49 reports in eight of twelve subdivisions with the remainder having fewer than ten reports. The big skate is not apparently numerous in any subdivision but is fairly evenly distributed in these inside waters (C). The geographical record of these catches (D) shows some small catch record concentrations in the following areas -- Lower Case Inlet, Henderson Bay, Port Orchard, Holmes Harbor, Penn Cove, Lopez Sound, East Sound, and Bellingham Bay off Bellingham. No comparable record summary exists for the western Strait of Juan de Fuca and coast.

Big skates were not taken in a beam trawl survey of Guemes Channel, East Sound and Cherry Point (I). This trawl may not be suitable for catching this species. In an ongoing North Sound Study (H), big skates (juveniles) were reported as an uncommon occurrence in the mixed/eelgrass habitat (as shown by beach seine). This species was caught there in June, July and November (H).

The commercial catch of skates (not specific) has been from otter trawling in the Gulf of Georgia and southern Puget Sound (J).

They are reported as "not common" in ocean surf sport catches (K). In the Grays Harbor study big skate are reported as "probably fairly rare visitors to the harbor and contribute little to its overall biology" (G). This species is not mentioned for Willapa Bay (E, F) but may similarly occupy the Bay as this skate occupies Grays Harbor. This skate may also utilize the lower Columbia River estuary.

HABITAT REQUIREMENTS - The big skate would use the open water habitat but has a very close association to the bottom from egg (in the case) through adulthood. In Washington skates (*Raja sp.*) are reported common on muddy bottoms and in some sandy areas (K). They live on the bottom and sometimes feed in shallow water where they can be observed with their pectoral fins undulating (J). They apparently occur in low numbers in the ocean surf zone and in coastal bays.

Juvenile big skates were taken in North Sound in the shallow mud/ eelgrass habitat (H), which may be their nursery area.

Big skates may follow tides coming onto shallow mud and sand flats to feed or deposit egg cases when the tide is in and retreating to deeper water when tides are out. Night tides may be preferred.

CRITICAL HABITAT AREAS - Big skates seem widely distributed in inside and possibly in outside waters at moderate depths. Areas of concentrated reports exist for inside waters but many are old records and few reports are for more than one to five reports from one area. One exception exists in Port Orchard (off Fletcher Bay to off south of Battle Point) where 43 skate came from one logged record and nine and less came from other logged records (D). This area is labeled F-40 on attached maps. Other areas of some concentration of big skates were also reported in prior sections. None has the apparent numbers indicated for this Port Orchard area. Another potential critical area would be the beds that the egg cases are laid in (for 15 months) (mud and sand areas) if egg cases are densely laid in selected bed areas.

DATA GAPS - A catch summary for the western Straits and coast should be completed. Other areas may become apparent in the western Strait of Juan de Fuca to better describe the big skate catches reported as few there (970) and in thousands of pounds (348) of skates (not specifically big skates) in Canadian waters of the Straits. This catch summary and other sources (C, D) would provide a historical base to begin trawl surveys of big skate concentrations in Washington waters.

Another survey (SCUBA and shallow water trawl) should be initiated to look for concentrations of big skate egg cases in nearshore shallow sand and mud area presumably below the intertidal zone. Any areas of concentrated egg casses should be checked for several years to see how consistently the area is utilized. The early life history (hatching young to shallow water juvenile should also be observed in these areas.

REFERENCES - A, C, D, E, F, G, H, I, J, K, 160, 272, 348, 373, 780, 970.

FACT SHEET

F-41 LONGNOSE SKATE

Raja rhina

LIFE HISTORY - The longnose skate, like all *Raja*, have internal fertilization and eggs in egg cases that are deposited on the bottom. This skate can copulate and lay eggs at any time during the year (780). Egg cases are between three to five inches with tendrils and usually contain one egg (166). No other specific information was located. If longnose skate follow the pattern of other *Raja* (F-40), the egg case is deposited (usually on shallow sand or mud bottoms and incubation is from 4.5 to 15 months depending on the species (M, N). Young coming from the egg case closely resemble the adults (J). They may go to nursery areas in mud/eelgrass or other shallow water mud/sand areas. They would be assumed to move to deeper water with age, but like big skates (F-40) adults do return for feeding and egg case deposition to shallow near shore sand/mud areas.

Migrations are not reported. Foods include bottom dwelling invertebrates and small fish (780).

The longnose skate grows to 4.5 feet (166) and appears in sport and commercial catches in Washington.

WASHINGTON DISTRIBUTION - Throughout British Columbia the longnose skate is common in trawl catches (166). They are taken to 203 fathoms (in California) (166).

In inside waters longnose skate is reported in somewhat greater reports than big skate with only one area -- Everett, having 50 or more reports (C). All other subdivisions have 10 to 49 reports, except the

Strait of Juan de Fuca and Admiralty Inlet, which have less than ten reports (C) and possibly the least sampling effort. In the geographic distribution of records (D), several areas stand out with concentrated reports -- Holmes Harbor, Penn Cove, Port Orchard, Seattle (Golden Gardens), Henderson Bay and East Sound. In the logged reports (D), Holmes Harbor has reports including 44, 16, 27 longnose skates, off Golden Gardens (Seattle) has one report of 49, Port Orchard has one report of 21, South Sound has reports of 34 (off Glen Cove) and 18 (off Minter Creek).

Longnose skates were not taken in two North Sound Studies (H, I) or in coastal bay studies (G, E, F). They have been observed in Grays Harbor (G).

Skates (not specific) are reported taken commercially in the Gulf of Georgia and southern Puget Sound (J) and are reported "not uncommon" in the ocean surf area (K).

HABITAT REQUIREMENTS - The longnose skate would use the open water habitat but have a very close bottom relationship from the egg (in the case) through adulthood. Skates (*Raja sp.*) in Washington are reported common on muddy bottoms and in some sandy areas (K). Skates live on the bottom and sometimes feed in shallow water where they can be observed with their pectoral fins undulating (J). They may occur in Washington surf zone but were not reported from coastal bays (G).

As speculated for big skates (F-40) these skates may follow the tides coming on to shallow mud and sand flats to feed or deposit egg cases when the tide is in and retreating to deeper water when tides go out.

Night tides may be preferred.

CRITICAL HABITAT AREAS - The longnose skate seems to be widely distributed in inside and possibly in outside waters (to 200 fathoms?). Catch record concentrations (D) appear for the following areas: Holmes Harbor, Seattle (off Golden Gardens), South Sound (off Penn Cove, and Minter Creek) and Port Orchard. These areas are labeled critical areas and designated as F-41 on the attached maps.

Other critical areas may exist if egg cases are deposited in concentrations in selected nearshore shallow water sand and mud areas.

DATA GAPS - See suggestions for big skate (F-40).

REFERENCES - C, D, E, F, G, H, I, J, K, M, N, 166, 780.

FACT SHEET

F-42 RATFISH

Hydrolagus colliei

LIFE HISTORY - Ratfish are a widely distributed species from 499 fathoms to shallow waters (166). They copulate and lay eggs throughout the year with greatest spawning activity in late summer and early fall (166). Spawning has been noted about October and November in the Bangor area of Hood Canal (780). An elaborate courtship precedes mating (166). Fertilized eggs are expelled in pairs each with an elongated, ridged, brown case (166). Extrusion is slow -- 18 to 20 hours, and is followed by the egg cases hanging from the female for four to six days (166). Later eggs are found entangled in the mud as seen in the intertidal zone (166). Young presumably hatch fairly well developed and possibly hide in shallower waters moving to deeper waters with age.

Migrations are not reported. Ratfish seek food by smell and eat mainly clams, crustaceans (crabs and shrimps), and fishes (166). Mussels and other small invertebrates are also reported (373, 780).

The ratfish grows to 38 inches (166) and occurs in commercial and sport catches in Washington.

WASHINGTON DISTRIBUTION - The ratfish is reported common throughout British Columbia, most abundant at 50 to 150 fathoms in inside waters but between 100 and 200 fathoms in outside waters (166). In Washington the ratfish is commonly taken from sandy bottomed areas in depths over 12 fathoms (K).

In inside waters the ratfish is very numerous based on past catch records (C), having 50 or more reports in nine of the 12 subdivisions of of these waters. Hood Canal, Port Orchard, and Colvos Passage have 10 to 49 reports (C). The geographical record of these catches show scattered concentrations all over these inside waters (D). No areas stand out from the rest. No similar catch summary exists for the western Strait of Juan de Fuca and coast.

The ratfish was not taken in one North Sound study (I), or in coastal bay studies (G, E, F). The ratfish was captured in the nearshore fish study in North Sound (H).

HABITAT REQUIREMENTS - The ratfish uses the open water habitat in a pelagic, near bottom existence as an adult. The egg in the case is on or in the bottom. Young are presumed to be bottom-oriented from hatching through adulthood. Adults may move away from the bottom in feeding and spawning but that is speculation.

Bottom types include sand/medium, silt, sand, solid rock, mixed: medium, and clay (A). They are reported from the low intertidal zone and deeper (A).

CRITICAL HABITAT AREAS - The abundance of ratfish all over inside waters and the abundance of catch record concentration areas prevents any critical habitat determination. Potential spawning and nursery areas are probably located in inside waters but life history information is lacking in Washington in the information reviewed.

DATA GAPS - Little information exists on the ratfish in Washington waters. A first step is the compilation of catch reports for the western Strait of Juan de Fuca and coast. With this and other sources (C, D), areas of concentration should be selected and resampled quarterly for two to three years. The sampling should tag fish and, if possible, look at their feeding habits, look at their reproductive status and look for them at varying positions in the water column besides on the bottom (i.e., midwater trawls, as well as bottom trawls).

If any areas of concentrated spawning are located, studies using SCUBA (if workable) and shallow water trawls should be undertaken to seek egg case concentrations. Laboratory experiments should be completed on incubation times with variable temperatures. Any egg case concentrations should be observed to look at hatching activity and locate where young ratfish go after hatching.

REFERENCES - A, C, D, E, F, G, H, I, K, 166, 373, 780.

FACT SHEET

F-43 WHITE STURGEON

Acipenser transmontanus

LIFE HISTORY - White sturgeon are anadromous fish, who differ from the green sturgeon (F-44), the latter preferring more saline waters (G). This species is the largest freshwater fish in North America (J). White sturgeon spend much or all of their lives in fresh water (166). These are slow growing fish. Males mature in 11 to 22 years and females in 11 to 34 years with a four to eleven year interval between spawning (166). The timing of movement up rivers for spawning is probably spring and early summer in the Chehalis River (218). In Willapa Bay, white sturgeon are believed to move upstream in late winter and early spring, although a few mature and immature fish are taken in the Bay during most months of the year (E). Tagging has shown movement between Grays Harbor and the Columbia River and some doubt exists as to whether the white sturgeon actually spawns in rivers tributary to Grays Harbor (G). If this is the case for Grays Harbor, it may also apply to Willapa Bay, which is closer to the Columbia River than Grays Harbor. In California (Sacramento River) adults move downstream in summer and young fish are not migratory (166). In British Columbia (Fraser River) the young are found in sloughs in the lower reaches (166). Migrations between Grays Harbor and the Columbia River are reported (G). Conceivably the few inside records of white sturgeon are migrants from Fraser River or these coastal bays or the Columbia River. Migrations in the marine environment would not seem frequent or of great distance because of the species' preference for

Foods of young white sturgeon include insect larvae and mysids (166), while adults eat spawning or spawned out eulachon (Fraser River) and sculpins, sticklebacks, lampreys, young sturgeon, crayfish and molluscs (166). Grays Harbor studies (G) indicate they also eat *Crangon* shrimp, ghost shrimp and flatfish. White sturgeon feed heavily on salmon carcasses in the fall (H. O. Wendler, WDF, personal communication).

The white sturgeon grows to a length of about 20 feet (166) and is an important commercial and sport species in Washington, but catches in salt water are a rarity. Fishing is in estuaries and fresh water.

WASHINGTON DISTRIBUTION - Few (eight) white sturgeon are reported in inside waters (C, D). Two of these are from Hood Canal (Big Beef Creek and Davis Creek) while the rest are scattered from the Strait of Juan de Fuca (Morse Creek) to Seattle (Duwamish Head) (D). No similar record exists for the western Strait of Juan de Fuca and coast.

The white sturgeon center of distribution is the Columbia River with small populations in Grays Harbor and Willapa Bay (J).

Green sturgeon (F-44) are more abundant in Willapa Bay than are white sturgeon (E). The reverse is reported in high freshwater inflow periods in Grays Harbor (G). White sturgeon may be suffering from overfishing as poundages are declining with time in Willapa Bay and Grays Harbor. The lower Columbia River sturgeon harvests have increased in recent years, while the upper river stocks have become severely depressed (J). The overall Columbia River catch is well below the 1890's harvest (J).

White sturgeon are most abundant in upper Grays Harbor from September to April when salinities in the area are the lowest (G). They are in the Harbor year-round (G). They may use the Chehalis for spawning but conflicting ideas exist. Ten-year average gillnet catches (1956 to 1965) in Grays Harbor showed peak catches in November (218).

fresh water and low salinities.

Willapa Bay white sturgeon are limited to the Willapa and Naselle River areas and some are seen in the Bay throughout the year (E).

HABITAT REQUIREMENTS - This species uses the open water habitat but is bottom-associated. White sturgeon utilize low salinity marine and estuarine waters near to sizeable rivers suitable for spawning. Questions exist as to whether the Chehalis, Willapa, and Naselle Rivers serve this purpose, as tagging shows movements between these coastal bays and the Columbia River. These bays may, to some extent, be nursery areas for Columbia River spawners, but "maximum abundance" catches in September through April in the upper Grays Harbor and lower Chehalis River (218) implies spawning does occur in that river.

Bottom types in marine and estuarine water would appear to be mud and sand in low salinity waters.

CRITICAL HABITAT AREAS - The available information indicates the upper Grays Harbor and lower Chehalis Rivers may be spawning areas. The Willapa and Naselle River areas may also be in this category. The Columbia River estuary and lower river are spawning areas. On the attached maps, the areas in Willapa Bay and Grays Harbor are mapped and coded (F-43). Additional information is required to locate spawning and nursery areas in the lower Columbia River where critical habitats for white sturgeon are sure to exist.

DATA GAPS - Unlike most fish species, the location of the bulk of the white sturgeon population in the state is known. Catch records for the western Strait of Juan de Fuca (to follow up on the Morse Creek - near Port Angeles record), coast (to fill in any more movement information from coastal bays to Columbia River), and coastal bays should be completed.

Tagging should be initiated on a large scale on all sizes of sturgeon caught in marine and estuarine areas. Surveys should be completed on the lower reaches (sloughs) of the Chehalis, Willapa and Naselle Rivers to locate any young sturgeon.

Fish captured in all areas (Grays Harbor, Willapa Bay, and Columbia River -- to Puget Island) should be fished in a standardized fashion so that densities can be interpreted with seasons of the year. Tagged to untagged catch ratios should be used to make population estimates.

REFERENCES - C, D, E, G, J, 166, 218.

FACT SHEET

F-44 GREEN STURGEON

Acipenser medirostris

LIFE HISTORY - Green sturgeon differ from white sturgeon (F-43) by their preference for salt water and brackish water (218). Not much life history information was located. They probably do not spawn in the Grays Harbor area (218) and this may be true for Willapa Bay. This would leave the Columbia River as the main or only spawning area for green sturgeon. This sturgeon apparently spends little time in fresh water and ascend rivers only a short distance to spawn. Early life history is not reported in the sources reviewed.

Juvenile green sturgeon are reported from May through early October in upper Grays Harbor when the salinities are the highest (218). In this period they were quite abundant in July through September (218). A similar pattern exists for Willapa Bay (E) -- peak abundance in highest salinity periods. Migrations occur in high runoff periods when green sturgeon move away from river mouths (K). Foods reported include mysids, amphipods, and *Corophium* (218).

The green sturgeon grows to seven feet (166) and is both a commercial and sport species in Washington.

WASHINGTON DISTRIBUTION - Only four records of green sturgeon exist for inside waters (C, D). Two are recent and from inside Dungeness Spit (D). No comparable records exist for the western Straits of Juan de Fuca and coast (including coastal bays). The bulk are from the coastal bays and Columbia River estuary. Green sturgeon are most common near and in the lower estuaries of the Columbia River and some other coastal rivers (K). Green sturgeon are in greater abundance as compared to white sturgeon in Willapa Bay (E) and appear to be the same in Grays Harbor at least on the basis of peak catches (ten-year average, 1956 to 1965) in July and September (218).

HABITAT REQUIREMENTS - This species uses the open water habitat but is bottom-associated. Green sturgeon in Willapa Bay seek the deepest waters of the bay, particularly in the south arm, except during high tide when they move onto the tide flats to feed (E). They prefer high salinities and move away from low salinities. Bottom types are mud and probably also sand in higher salinity waters.

They are abundant in upper Grays Harbor (July through early October) when salinities are highest (G).

CRITICAL HABITAT AREAS - The green sturgeon's main habitat appears to be the Columbia River area although no specific areas were located. Deeper channels of the south arm of Willapa Bay and the upper Grays Harbor area are defined as critical areas (marked F-44 on attached maps). Surely critical areas exist in the lower Columbia River estuary but these were not located on the basis of information reviewed.

DATA GAPS - See white sturgeon (F-43).

REFERENCES - C, D, E, G, K, 218.

FACT SHEET

F-45 CUTTHROAT TROUT (COASTAL)

Salmo clarki

LIFE HISTORY - The cutthroat trout (coastal) is the first species in this series that has been manipulated by man (stocking hatchery-reared fish). In many places, hatchery stocks have been superimposed on wild stocks (P). The effects of the hatchery introductions on wild stocks and the performance of hatchery trout is little understood (P). There is basically very little biological information about wild coastal cutthroat populations in Washington waters (P). Even less is known about the estuarine and marine portions of this anadromous species' life history. Two recent studies (O, P) encompass most of what is known about coastal cutthroat trout in saltwater, with the former study from the open Oregon coast and the latter from lower Hood Canal. The Hood Canal study (WDG) is ongoing and should provide additional insights about this species. This life history section will therefore generalize an already varied life history between inside and outside water groups of cutthroat trout.

This trout is anadromous, with the majority of those in streams with access, going to sea. Residualism (remains in fresh water) is seen, particularly in some hatchery fish. This trout matures in three to four years (64, 166). In smaller streams this may occur at a smaller size (166). Fecundity is reported at 750 eggs/female (64). Spawning is reported late winter to early spring (K) and February to May (780). This trout does not die after spawning (64). Young move downstream at two to three years old in the Chehalis River (218) and at two to five years old in coastal Oregon (O). If an estuary exists, the young may spend some time there -- "briefly" in the spring, using the estuary as a staging area for migrant groups or schools departing for the sea (O).

In the marine and estuarine environment, this trout does not apparently make great migrations but does stray to adjacent river systems (in Oregon, O). The stay in the estuary and marine area appears shorter in the open coast (mid-spring to fall, O) than in Hood Canal where cutthroat trout may be in saltwater through the winter (P). In the Chehalis River downstream migration is reported between March and September (218) but non-migratory stages of the trout or other species may account for the late summer and fall migration, as reported for Oregon streams (O).

Hood Canal estuarine and marine cutthroat trout (adult) residence is from May through January with the length of stay dependent on size of parent stream and their spawning location (high, low, etc.) in that stream (James Johnston, WDG, personal communication). Fall spawners in bigger streams peak in the estuary in August (range: July to October) while small streams spawners are abundant through fall and early winter (range: November to January) (James Johnston, WDG, personal communication).

The important thing to emphasize is the variability in the timing of cutthroat trout activity which depends on variables that include the river involved, the stock of fish (wild, hatchery), the source of the hatchery stock, and climatic conditions influencing temperatures and water flows, primarily. See sources (O, P) for additional details.

Migrations are not extensive as compared to steelhead trout, but straying occurs (maximum of about 80 miles) on the Oregon coast (O).

Food includes crustaceans and insects (young trout) and coho salmon, sticklebacks, rockfish, sculpins and flatfish (adult trout) (166). In Oregon estuaries, young coastal cutthroat trout ate sand shrimp (major food) and fish (northern anchovy, shiner perch, and Pacific herring), while larger trout ate smelt and perch species (O). These trout were found to stop feeding in the summer and fall when returning to these Oregon rivers (O).

The cutthroat trout (sea-run) grow to four pounds (166) and are an important sport fish in Washington.

WASHINGTON DISTRIBUTION - The range of cutthroat trout is generally through Puget Sound and along the ocean coast of Washington (64).

In inside Washington waters, the cutthroat trout (*S. clarki*) is reported in all subdivisions except Georgia Strait and in reports of 50 or more in the Everett area, Hood Canal, Colvos Passage and South Puget Sound (C). The geographical distribution of these reports shows reports scattered along the coastline of most of the inside waters except parts of the San Juans and eastern Strait of Juan de Fuca, the west shore of Whidbey Island, the west side of Admiralty Inlet and the northern part of Hood Canal (east shore) (D). This may relate to a reduced number of adjacent spawning streams.

No comparable summary exists for the western Strait of Juan de Fuca and coast.

In a recent beam trawl survey of North Sound no coastal cutthroat were taken (I) as might be expected. In an ongoing nearshore study (*S. clarki*) was reported as uncommonly occurring in the gravel habitat (as shown by beach seine) (H). This species was caught only in March (H).

Coastal cutthroat trout occur in Willapa Bay and Grays Harbor (E, F, G). Juvenile trout were taken in the upper Harbor from March to early September (218). Cutthroat trout can be found in Willapa Bay in most months of the year with adult migrations in July through December (E). Willapa Bay's estimated spawning population (approximate five-year average, 1961 to 1965) was 106,500 (E).

Coastal cutthroat are presumed also in the Columbia River estuary to Puget Island.

HABITAT REQUIREMENTS - The habitat requirements for this anadromous species excludes the fresh water requirements except to note that accessible fresh-water streams must be near the marine and estuarine areas described. This species uses the open water habitat type near shore and is pelagic and somewhat bottom-oriented. Gravel habitat was where this trout was caught in North Sound (H). The following habitat composite (James Johnston, WDG, personal communication) is for marine and estuarine areas in Hood Canal:

1. Generally over gravel bottom ("mixed-coarse"?)
2. Slope of two to eight percent
3. Fairly good current (1 fps or greater), even tide rip areas
4. Close to shore in one to six feet of water.

This source reports the fish are active one hour before to one hour after both high and low tides and fish are in "pockets" -- "schools" in consistent areas. Schools of fish are also reported on the Oregon coast (O).

This trout is located in the flooded intertidal zone of most Washington areas (K, 364). Limited evidence indicates they do not move far offshore on the Oregon coast (O).

CRITICAL HABITAT AREAS - Coastal cutthroat trout appear to utilize the shallow, gravel-bottomed intertidal zone in inside waters. In coastal bays the bottom type may also include sand and mud. While in the marine and estuarine area (varies three months to possibly several years), this nearshore zone appears to be the exclusive area used. This region, while necessary habitat for coastal cutthroat trout, seems scattered over much of Washington's inside waters (D) and presumably also in outside coastal waters (excluding, perhaps, the sand beach surf zone areas). No areas of a critical nature stand out in this marine and estuarine habitat, although the larger producing cutthroat rivers might be considered more critical on the base of numbers. All of these shallow intertidal areas are important except in areas where cutthroat do not exist or are in small numbers (see Washington distribution).

DATA GAPS - Coastal cutthroat trout catch records should be summarized for the western Strait of Juan de Fuca and coast. Studies similar to that described by sources (P, O) should be initiated to determine natural stocks of this trout. Sampling and tagging should also be completed in areas outside of the south end of Hood Canal. The evaluation of hatchery fish on wild stocks should be further assessed. Marine and estuarine sampling could use gill nets, fyke nets and beach seines. SCUBA might be useful to observe cutthroat in this habitat.

REFERENCES - C, D, E, F, G, H, I, K, P, O, 64, 166, 218, 780.

FACT SHEET

F-46 KELP GREENLING

Hexagrammos decagrammus

LIFE HISTORY - The kelp greenling adult is a nearshore shallow water species found on rocky shores. The juvenile is pelagic and is found on the high seas and probably occurs in the open waters of Puget Sound and the Strait of Juan de Fuca and coast. Spawning occurs in September to November (B), October to November (166), in British Columbia, and November to December in California (B), when eggs are laid in large masses attached to rocks and algae. If like rock greenling (F-47), this may occur in shallow rocky/kelp bed areas up as far as the low intertidal. In the Bering Sea newly hatched larvae are 8 mm and they spend about a year in a pelagic period, sometimes 500 to 600 miles off shore (B). Off California the smallest larvae have been encountered in December (B). In the Strait of Georgia (southern) young (17 to 60 mm) were located near the surface in late spring (166). Young (25 to 76 mm) are commonly taken in the high seas of the Gulf of Alaska (166). Young are presumed to become more bottom-associated with age moving near shore or to shallow water reefs.

Migrations of the pelagic juveniles in Alaska could be quite extensive if high seas kelp greenling return to near shore areas as adults.

Food of young (17 to 60 mm) is mainly copepods and some amphipods and other crustaceans as well as small fish (young walleye pollock) (166).

Adults eat worms, crustaceans, and small fish (166, 373, 780).

Kelp greenling grow to 21 inches (166) and are utilized by sport anglers in Washington.

<u>WASHINGTON DISTRIBUTION</u> - The kelp greenling is abundant along rocky shores throughout coastal British Columbia (166). In inside Washington waters, a catch summary (C) indicates no subdivisions with 50 + reports and four subdivisions -- Georgia Strait, Hood Canal, Colvos Passage, and South Puget Sound -- having no records at all. Most of the remaining areas had "10 to 49 reports" (C). The geographical records of these catches (D) show concentrated reports off West Point, Shilshole Bay, Edwards Point, Appletree Cove, Whidbey Island (northwest end at Deception Pass), and the south and east shores of San Juan Island. No comparable summaries exist for the western Strait of Juan de Fuca and coast.

A recent North Sound beam trawl survey (I), did not take kelp greenling. In an ongoing North Sound study (H), this species was reported as -

common occurrence:	in gravel habitat (as shown by beach seine)
	in rocky/kelp bed (as shown by trammel net and SCUBA)
uncommon occurrence:	in mud/eelgrass (as shown by beach seine and tow net)
	in cobble and rocky/kelp bed (as shown by tow net).

Timing of the capture in the gravel habitat was all year except December through February, while capture in rocky/kelp bed habitats was essentially all year (H).

In coastal bays only juvenile kelp greenling were taken (G) (or "primarily small juveniles", in Grays Harbor (218). No kelp greenling were taken in the winter in Grays Harbor (G). The kelp greenling was caught only at Whitcomb Flats where they were uncommon (G). Kelp greenling are not reported in Willapa Bay (E, F) but may be the "other fish" for which there is no data. The Columbia River estuary may also have this species.

HABITAT REQUIREMENTS - The kelp greenling uses the open water habitat type, particularly as a pelagic juvenile, but is very bottom-associated in some life stages (as attached eggs and bottom-located adults). The adults are found along rocky shores (166). They are said to prefer rocky shores, reefs, and kelp beds (218, K) in areas below the intertidal zone (K). Mud/eelgrass, cobble, and gravel habitats are also reported for kelp greenling in North Sound (H). These may be smaller, younger individuals.

The pelagic juvenile occupies near surface waters and is a food for steelhead and salmon (166).

CRITICAL HABITAT AREAS - From the data reviewed no areas of concentrated activity (spawning, feeding, nursery areas) stand out for this species. The concentrations of reports (D) may be to a good extent influenced by much greater sampling efforts in the few areas noted (see Washington Distribution). Little is reported of this species' life history in Washington, particularly for the hatched young to the nearshore adult stages. No areas are designated for this species, partially because of the apparent abundance in British Columbia waters.

DATA GAPS - A first step with kelp greenling would be a catch summary for the western Straits and the coast of Washington. Using that information and other sources (C, D, 218), a survey should be completed in areas of concentration in September to December. See ling cod (F-2).

REFERENCES - B, C, D, E, F, G, H, I, K, 166, 218, 373, 780.

FACT SHEET

F-47 ROCK GREENLING

Hexagrammos lagocephalus

LIFE HISTORY - The rock greenling is apparently much less numerous in Washington than the kelp greenling (F-46). Little life history information was located. In the Bering Sea, the rock greenling spawns from mid-June through September (B). Spawning sites (Bering Sea) are on rock and algae areas with strong currents and "well warmed" water, usually around capes (B). The spawned egg masses are surrounded by slime (B). Eggs develop in 6 to 10 degree C water and hatch in about one month (B). Larvae (newly hatched) are about nine millimeters long and become pelagic. This occurs in the open ocean, a considerable distance from shore (B). With age the juveniles move to near bottom and bottom locations for a quite sedentary adult stage.

Extensive migrations of adults are not reported. Juveniles, while pelagic, may make quite extensive migrations.

Foods include euphausiids (166). In Alaska the diet was mainly amphipods, with mysids, molluscs, fish, decapods, and copepods in declining importance (921).

The rock greenling grow to 24 inches (166) and are a potential sport fish if large enough numbers exist in Washington.

WASHINGTON DISTRIBUTION - The rock greenling is generally distributed throughout coastal British Columbia including Vancouver Island (west coast), the Queen Charlotte Islands and the Strait of Georgia (166).

For inside Washington waters, only 20 records exist with these scattered in the San Juan Islands, Bellingham, Everett, Admiralty Inlet, Central Puget Sound, Port Orchard and Seattle subdivisions (C). The geographic summary (D) indicates the largest single record for inside waters as four specimens in Port Orchard. A similar summary does not exist for the western Strait of Juan de Fuca and open coast.

The North Sound beam trawl survey (I) did not capture this species. In another ongoing North Sound nearshore fish survey (H), the rock greenling was not taken where it might be expected. This possibly indicates a scarce abundance of rock greenling in North Sound.

The rock greenling was not reported in coastal bays (G, E, F) and may not occur in the Columbia River estuary. This greenling would be expected on the rocky open (north) coast and western Strait of Juan de Fuca, if the pattern for British Columbia holds in Washington.

HABITAT REQUIREMENTS - See kelp greenling (F-46) as rock greenling are assumed to have similar requirements.

CRITICAL HABITAT AREAS - No critical areas are located on the basis of the data reviewed. If catch records for the western Strait of Juan de Fuca and north coast do not show some abundance of rock greenling, a question would exist as to whether this species is a "significant" marine fish in Washington.

DATA GAPS - See kelp greenling (F-46)

REFERENCES - C, D, E, F, G, H, I, 166, 921.

FACT SHEET

F-48 WHITESPOTTED GREENLING

Hexagrammos stelleri

LIFE HISTORY - The whitespotted greenling, like other greenling (F-46 and F-47) is presumed to be a shallow water near shore fish as adults, after having a larval and juvenile pelagic stage. Little life history information was located. Spawning in northern regions (Bering Sea?) was in summer (July) and in southern regions (to California?) it spawns in early autumn (September) (B). Larvae and fry pass through a pelagic stage and sometimes are considerable distances off shore (B) similar to kelp greenling (F-46) and rock greenling (F-47).

Migrations could be extensive if far offshore pelagic larvae and fry return to nearshore waters. Migration as larvae and fry may be fairly passive, dependent on currents.

Food of young whitespotted greenling include copepods, amphipods, decapod larvae, ostracods, barnacle larvae, fish eggs and *Oikoplera*, while adults eat worms, crustaceans, and small fish (166).

The whitespotted greenling grows to 16 inches (166), and is utilized by sport anglers.

WASHINGTON DISTRIBUTION - The whitespotted greenling is generally distributed in coastal British Columbia waters along rocky shores (166). This greenling appears to be somewhat more abundant than kelp greenling (F-46) in inside Washington waters. In the catch summary for these waters (C), whitespotted greenling are reported in "50 or more" reports in Port Orchard only and are not reported in Georgia Strait. Most of the remaining ten subdivisions of these inside waters have "10 to 49" reports (C). The pattern of the geographic catch records (D) shows concentrated reports around Bainbridge Island, off West and Alki Points, in the Friday Harbor vicinity, and off Bellingham. No comparable summaries exist for the western Strait of Juan de Fuca and coast.

In the North Sound beam trawl survey (I), this species was not captured. In an ongoing North Sound study (H), this greenling was reported as occurring commonly in the gravel habitat (as shown by beach seine) and uncommonly occurring in the rocky/kelp bed (as shown by trammel net).

The whitespotted greenling (adults) were taken in the rocky/kelp bed in May and in the gravel habitat in July through November, January and May (H). Juvenile whitespotted greenling were taken in the cobble habitat in April, in the mud/eelgrass habitat in May to June, and in the gravel habitat May to July and September (H).

This species was not taken in coastal bays (G, E, F) and may not exist in the Columbia River estuary. This species is expected in the western Strait of Juan de Fuca and rocky north coast if distributed as in British Columbia.

HABITAT REQUIREMENTS - See kelp greenling (F-46) as whitespotted greenling are assumed to have similar requirements.

CRITICAL HABITAT AREAS - No critical areas are located on the basis of data reviewed. Catch concentrations are seen in inside waters, but so little is known about this species in Washington, critical areas could not be designated. These concentrations and others in the western Strait of Juan de Fuca and north coast (if located) should be further studied.

DATA GAPS - See kelp greenling (F-46) and lingcod (F-2).

REFERENCES - B, C, D, E, F, G, H, I, 166.

FACT SHEET

F-49 BUFFALO SCULPIN

Enophrys bison

LIFE HISTORY - One survey (A) has "no information stored" and little is known from the information reviewed. The buffalo sculpin spawns in February and March and deposits eggs in small clusters (orange-brown color) (166). Young are 11 mm long by June in southern British Columbia. They spawn near shore if like other *Encphrys* (B). The larvae to adult stages are not described.

Migrations are not reported. Foods of adults include: Shrimp, crabs, amphipods, mussels, young herring, salmon (small), sea perches, sand lance, and sea lettuce (*Ulva*) (166). In Grays Harbor (winter) two buffalo sculpin "had eaten macroalgae and little else" (G).

The buffalo sculpin grow to 12 inches (166), and are commonly taken by young sport anglers.

WASHINGTON DISTRIBUTION - In British Columbia, the buffalo sculpin is taken on beaches (166). In inside Washington waters, a catch summary (C) shows this species was taken in all 12 subdivisions, with "50 or more" reports in Bellingham and Everett areas. Half of the subdivisions have "10 to 49 reports". The geographical distribution of these records (D) shows concentrations in the north half of Bellingham Bay, West Point and Shilshole Bay, Alki Point, and Hood Canal (off Union). No comparable survey of catches exists for the western Straits and coast.

The North Sound beam trawl survey (I) did not capture the buffalo sculpin. An ongoing North Sound Study (H) reports this species as commonly occurring in mud/eelgrass, sand/eelgrass, gravel and cobble habitats (as shown by beach seine) and as an uncommon occurrence in the rocky/kelp bed habitat (as shown by trammel net). Buffalo sculpin (adults) were in these habitats most of the year while juveniles were seen only in April to May and July in these habitats (H).

In Grays Harbor only two buffalo sculpin were taken and these were in North Channel in Winter (G). This species is not reported in Willapa Bay (E, F) but may also be rare there. The same may be true for the Columbia River estuary.

If a short or non-existent pelagic larvae stage is presumed, and if a hard substrate is required for spawning, the southern coast and coastal bays of Washington may not support many buffalo sculpin.

HABITAT REQUIREMENTS - Little is known to say what habitats are required, if any, as a lot of habitat types are used. The buffalo sculpin would use the open water habitat but a near shore bottom associated life is presumed for adults, older juveniles, and eggs. The degree of pelagic existence of larvae and young juveniles is not known. This nearshore area includes the intertidal "beaches" (166) which may be the species' predominant living area. All habitat types are used in North Sound (H).

The buffalo sculpin occurs on the bottom near rocks, rubble or pilings in shallower water with an abundance of seaweed (K)

CRITICAL HABITAT AREAS - Too little is known of this species' life history to say what might be critical. No areas are designated. Buffalo sculpin appear well distributed in Washington except possibly where limited by spawning substrate (which is speculated for the southern coast and coastal bays). The areas of concentration (D) may be the areas that have been sampled the hardest or some may, in fact, represent concentrations of buffalo sculpin in some life history activity.

DATA GAPS - The buffalo sculpin's life history appears to be a large data gap. The substrates for egg deposition, parental care, as well as hatching time, larval location, foods and migrations, are not discussed in information reviewed. Once a catch summary for the western Strait of Juan de Fuca and coast is completed, February to March concentrations should be surveyed for concentrated spawning activity. The general procedures would include SCUBA where visibility permits, trawls, in deeper waters, seine and trammel net in shallower locations. Once spawning areas are located, individual egg masses should be monitored along with physical oceanographic parameters (temperature and salinity) to see time of spawning and hopefully locate new larvae. If egg masses are pelagic, plankton type net sampling should seek larval concentrations both regionally and vertically in the water column. The juvenile and adult stages would have to be sought in all nearshore habitats making the sculpin a difficult species to fully assess.

REFERENCES - A, B, C, D, E, F, G, H, I, K, 166.

FACT SHEET

F-50 RED IRISH LORD

Hemilepidotus hemilepidotus

LIFE HISTORY - The red Irish lord is another shallow water sculpin. This species spawns in March (southern British Columbia, 166, and Bangor area, 780), laying conspicuous masses of tough pink eggs in shallow waters and the intertidal zone (780, 940, 166). In April in southern British Columbia the young are 16 to 22 mm (166) and presumably pelagic. Little other data was located for red Irish lord.

Migrations are not reported. Food of young red Irish lord is copepods, while adults eat crabs, mussels, and barnacles (166).

This species utilizes camouflage for protection (940).

The red Irish lord grows to 20 inches (166), and is taken only occasionally by sport anglers in Washington.

WASHINGTON DISTRIBUTION - This sculpin is common along the inside coast of British Columbia (166). In inside Washington waters, a catch summary (C) has no "50 or more" reports in any subdivision and no reports in three subdivisions - Georgia Strait, Port Orchard, and Hood Canal. The majority of the remaining subdivisions have fewer than ten reports (C). The geographic distribution of the catches (D), shows small concentrations off Alki Point, and on the south shore of San Juan Island. No comparable record exists for the western Strait of Juan de Fuca and coast.

In a North Sound beam trawl study (I), red Irish lord were not taken, indicating they are probably in shallow water possibly too rough to trawl. In an ongoing North Sound study, this sculpin was noted as a common occurrence in the gravel habitat (as shown by beach seine) and in the rocky/kelp bed (as shown by SCUBA) (H). Red Irish lord were located in the gravel habitat in July to September and May and in the rocky/kelp bed habitat in July, September, December, and March (H).

This sculpin was not caught in Grays Harbor (G) or reported in Willapa Bay (E, F). This species may exist in the western Strait of Juan de Fuca and North Coast.

HABITAT REQUIREMENTS - The red Irish lord utilizes the open water habitat but is very closely associated with the bottom with the exception of a presumed pelagic larval stage after hatching. Eggs are attached to rock or algae and juveniles and adults are closely associated with the bottom and algae there. Bottom habitats noted in North Sound were gravel and rocky/kelp bed (H). The red Irish lord occurs on the bottom near rocks, rubble or pilings below and in the lower intertidal zone (K).

CRITICAL HABITAT AREAS - Little information exists for red Irish lord life history and habitat requirements. Their distribution in the western Strait of Juan de Fuca and north coast was also not described.

The reports in inside waters show three small record concentrations--Alki Point, Shilshole Bay, and the south shore of San Juan Island. However, the largest catch at any site -- Alki Point -- was ten fish.

Based upon the poor understanding of this species' life history in Washington, and the small numbers in inside waters, no critical habitats were determined.

If numbers are not greater in the western Strait of Juan de Fuca and north coast than appear to exist in inside waters, the red Irish lord may have to be reconsidered as a "significant" marine fish of Washington.

DATA GAPS - See Buffalo Sculpin (F-49).

REFERENCES - C, D, E, F, G, H, I, K, 166, 780, 940.

FACT SHEET

F-51 PACIFIC STAGHORN SCULPIN

Leptocottus armatus

LIFE HISTORY - The Pacific staghorn sculpin is the most numerous sculpin in inside Washington waters. Males and females mature at one year of age (406). Spawning takes place in February (166) or late winter to early spring (G), probably in bays of relatively stable salinity (based on laboratory studies) (406). Eggs have been observed from October in California (406) to April in Grays Harbor (218). Spawning is presumed spread over a greater time period than one month--February. This species spawns only once a breeding season (406). Hatching occurred in ten days in the laboratory (406). Fry and juvenile Pacific staghorn sculpin are reported pelagic/midwater and pelagic/surface and midwater in one survey (A).

In Grays Harbor (G) sizes of this sculpin seemed to increase with depth and proximity to the harbor mouth and numbers were greater in the ummer compared to the winter.

Migrations of this shallow water sculpin have been reported. Staghorn sculpin move into deeper water (16 fathoms) during the day in winter (93). Other sources (103, K) indicate they remain in waters shallower than 0.5 fathoms, or just below the intertidal zone and imply they stay there. Migrations do not appear extensive in adults while pelagic fry and juveniles move passively and actively for greater distances.

Food included mainly invertebrates (166, 373). Juvenile staghorn sculpins ate shore crab (*Hemigrapsus*) and other invertebrates while adults ate shrimp, anchovies, and shore crab (*Hemigrapsus*) (406). Barnacles and mussels are also reported foods (780).

This sculpin grows to 18 inches (166) and provides a great deal of recreation to young sport anglers in Washington

WASHINGTON DISTRIBUTION - The Pacific staghorn sculpin is very abundant throughout British Columbia in tide pools and at moderate depths (166). Inside Washington waters catch summaries (C) indicate this is the most reported sculpin in Washington, being found in all twelve subdivisions. Six subdivisions have "50 or more" reports while only two subdivisions--Georgia Strait and Colvos Passage--have "fewer than ten reports" (C). The geographical distribution of these catches of staghorn sculpin (D) indicate this species is reported from almost every area with the exception of deeper open water areas (Strait of Juan de Fuca, Georgia Strait, Admiralty Inlet, etc.) Comparable summaries do not exist for the western Strait of Juan de Fuca and coast.

The North Sound beam trawl survey (I) found this sculpin least abundant at East Sound relative to Guemes Channel and Cherry Point and almost totally absent from all stations in winter and spring. The tendency was for a greater abundance at the middle depths (5.5 to 8.2 fathoms) sampled (I).

An ongoing North Sound study (H) found this sculpin as a common occurrence in all habitats (as shown by beach seine and tow net). The staghorn sculpin (adults) were seen throughout the year in most of these habitats, while juveniles were only found in the mud/eelgrass habitat in May and July (H).

In Grays Harbor, this sculpin was found to be the most abundant and widely distributed fish and was more abundant in summer than winter (G). They were also larger in deeper waters of the Harbor as well as larger close to the Harbor mouth (G). They were common in the upper Harbor and lower Chehalis River except when salinities were low due to high river flows (late fall to early spring) (218).

Although not specifically mentioned in Willapa Bay (E, F), staghorn sculpin are probably as numerous there as they are in Grays Harbor. They may also be in the lower reaches of the Columbia River estuary.

Distribution on the North Coast and western Strait of Juan de Fuca would probably be limited to sandy/gravel beach cove areas. They apparently avoid surf (K).

HABITAT REQUIREMENTS - Sandy and mixed sand and rock (mixed fine; mixed coarse) bottoms within and just below the intertidal zone is the reported habitat. Pacific staghorn sculpin utilize the open water habitat but become bottom-associated through the late juvenile, adult, and presumably the egg stages of life. Larvae and young juveniles are pelagic/midwater and surface. Bottom types ranged from mud/eelgrass, sand/eelgrass, gravel and cobble, to rocky/kelp bed. One study (H) indicated this sculpin is quite adaptable to a wide variety of bottom and shore types.

CRITICAL HABITAT AREAS - This species is quite numerous and scattered, having no definable specific habitat requirements. A wide range of bottom substrates are reported indicating flexibility in habitats used. No critical habitat areas are apparent for this species, although one area (Moon Island Flats in Grays Harbor) was indicated as a possible nursery area because of the small (19 mm) sculpins taken there. There must be many other areas in inside waters comparably used by staghorn sculpin.

Coastal bays (Grays Harbor and Willapa Bay) may well serve as staging areas for juveniles that recruit into outside stocks with age, if the winter absence and size difference with proximity to the Grays Harbor mouth can be construed to indicate this.

DATA GAPS - Information reviewed is from Canada and California. More detailed information on the Washington life history should be obtained both in the laboratory as well as in the field, as described for buffalo sculpin (F-49). Catch records for the western Strait of Juan de Fuca and coast should be worked up for this species.

REFERENCES - A, C, D, E, F, G, H, I, K, 93, 103, 166, 218, 373, 406, 780.

FACT SHEET

F-52 TIDEPOOL SCULPIN

Oligocottus maculosus

LIFE HISTORY - As the name implies, this is a tidepool sculpin around rocky shores. Females mature at about one year (166). Eggs are deposited on rocks. Spawning in the Bangor area of Hood Canal was January to March (780) as eggs were seen at that time. Two fry were located in the Bangor area in January (945) indicating spawn may also occur earlier (December?). Larvae and young juveniles are presumably pelagic. Older juveniles move to a bottom association with time.

Migrations are not reported except to indicate a return to a home pool if moved (166). Distances are not specified.

Foods include small crustaceans, worms, mussels, and crabs (285, 780, 944).

The tidepool sculpin grows to a length of 3.5 inches and probably provides some recreational use in Washington.

WASHINGTON DISTRIBUTION - The tidepool sculpin is generally distributed in Coastal British Columbia (166) and presumably similarly distributed in Washington. In inside Washington waters catch records indicate no tidepool sculpin in two subdivisions - Georgia Strait and Port Orchard, and two areas with "10 to 49 reports" - San Juan Islands and Seattle and remaining areas with "fewer than ten reports" (C). The geographic distribution of these records (D) show concentrations in Shilshole Bay area, all shores of San Juan Island (except north) and Iceberg Point (Lopez Island). These concentrations may be "University of Washington related" and not necessarily a true picture of this species' distribution. No comparable records exist for the western Strait of Juan de Fuca and coast.

As might be expected, a North Sound beam trawl survey (I) did not capture this species. In an ongoing North Sound Study (H), the tidepool sculpin was of common occurrence in the mud/eelgrass and gravel habitats and of uncommon occurrence in the sand/eelgrass and cobble habitats (as shown by beach seine). This sculpin was found in mud/eelgrass in all months except March, April, and June, and similarly in the gravel habitat except that none were taken in December-January (H). Sand/eelgrass catches were limited to one month - November - and cobble habitat catches to two months - August and October.

This sculpin was not taken in Grays Harbor (G) and was not reported in Willapa Bay (E, F). The Columbia River estuary may not have tidepool sculpins. All these areas have limited tidepool habitat, although that may not be necessary for this species.

<u>HABITAT REQUIREMENTS</u> - The tidepool sculpins utilize the open water habitat, particularly at the presumed pelagic larvae and young juvenile stages, but with age become bottom-associated.

The information reviewed is not clear on how necessary tidepools are for this species as other bottom types are used. Tidepools may well be necessary for successful spawning or nursery areas. Other areas may provide general feeding areas until the spawning period. Although later than the

Bangor area spawning time (January to March), this reproductive activity may explain the March, April and June absence of tidepool sculpin in North Sound study habitats.

Bottom types reported in the literature survey (A) include pulpy peat, mixed: medium, mixed: fine, sand, sand/medium, silt, solid rock and boulder. At some life stages the tidepool sculpin appears to utilize a wide variety of bottom types. Rocks are mentioned (166) as the substrate for egg attachment.

CRITICAL HABITAT AREAS - Tidepool sculpin, with a few exceptions, are scattered over much of Washington's inside waters in small numbers. They also have little life history information and an apparent wide variety of substrates are used as habitats. These conditions prevent any critical habitat determination for tidepool sculpin.

DATA GAPS - See buffalo sculpin (F-49).

REFERENCES - A, C, D, E, F, G, H, J, 166, 285, 780, 444, 945.

FACT SHEET

F-53 CABEZON

Scorpaenichthys marmoratus

LIFE HISTORY - Cabezon is one of the larger sculpins and can weigh up to 25 or 30 pounds (166). Males mature at two to three years, females mature at three to five years (776). Fecundity is reported from 49,000 to 95,000 eggs/female depending on size (166). Eggs are toxic and unwholesome (166). They are stuck prominently on rocks in shallow waters including the low intertidal (166). Eggs are spawned in several batches in California (166). Hatched fry are pelagic (776) and are found:

South Puget Sound and Hood Canal in April-May (461)

Pacific Northwest waters in November-March (518).

This time spread may indicate a fairly long pelagic period. Older juveniles presumably become bottom-associated with time.

Migrations are not discussed but probably occur (actively or passively) from the hatched larvae to the bottom-associated juvenile stages. Bottom-associated stages are probably not very migratory.

Foods of cabezon are as follows (166):

Young (less than 11 mm) - copepods, their nauplii, amphipods and barnacle larvae;

Young (14 to 22 mm) - copepods and fish larvae;

Juveniles and adults - crustaceans, fishes, and molluscs.

Cabezon grow to 30 inches (166) and are important in the diver harvest. Relatively few are taken by the sports angler in Washington.

WASHINGTON DISTRIBUTION - In British Columbia, cabezon are abundant at moderate depths (30 to 40 fathoms, 776) with adults sometimes in very shallow water (0.5 fathom) (166). In inside Washington waters, a catch summary (C) indicates cabezon not reported from one area - Georgia Strait, and in "50 or more" reports in one area - Port Orchard. Most other subdivisions have "10 to 49 reports" of cabezon. The geographic distribution of these cabezon catches (D), shows several concentrated areas - Friday Harbor, West Point - Shilshole Bay, Alki Point, Port Orchard and Squamish Harbor (Hood Canal). The biggest catches were 26 and 29 fish off Golden Gardens (D). No comparable record exists for the western Strait of Juan De Fuca and coast.

The cabezon was not taken in a North Sound beam trawl survey (I) which agrees with historical catches (few in the three sample sites). An ongoing North Sound Study (H), found the cabezon an uncommon occurrence in four habitats - mud/eelgrass, sand/eelgrass, gravel, and cobble (as shown by beach seine) and in the rocky/kelp bed (as shown by trammel net). Only adults were found in the rock/kelp bed habitat and then only in January, March and May. Juvenile cabezon were captured in the mud/eelgrass and sand/eelgrass habitats only in July, in the cobble habitat in August and October, and in the gravel habitat in November and January (H).

Three juvenile cabezon were taken at Whitcomb flats in Grays Harbor in Summer (G). Cabezon are not reported in Willapa Bay (E, F); but a few may be there and in the Columbia River estuary.

Cabezon should be present in protected areas in the western Strait of Juan de Fuca and North Coast.

HABITAT REQUIREMENTS - The cabezon uses the open water habitat but is bottom-associated in late juvenile, adult, and egg stages. Larvae and young juveniles are pelagic (776, 518) but the position in the water column is not noted.

Adults are reported below and in the lower intertidal zone, usually on rock and sand bottoms (K). Depths of 30 to 40 fathoms over a hard bottom are reported as the adult habitat (776). Eggs are attached to rocks (166).

The literature survey (A) reports the cabezon associated with the following bottoms: solid rock, silt and mixed: fine.

Adult cabezon were taken only in the rocky/kelp bed habitat while juveniles were irregularly taken in the four other habitats in the North Sound Study (H). Possibly a less specialized bottom association exists for juveniles and their reproduction or protection makes adult cabezon more specialized in use of rocky/kelp bed areas.

CRITICAL HABITAT AREAS - Cabezon in inside waters have several areas of apparent concentration although the Seattle vicinity areas are surely much more sampled than most other areas. The life history information is scarce for Washington cabezon. Concentrated spawning and/or nursery areas are not noted in the information reviewed and no critical areas stand out. Possibly, SCUBA diver records may show some concentrated spawning areas. No areas can be described from the information reviewed.

DATA GAPS - Catch records of cabezon for the western Strait of Juan de Fuca and coast should be summarized. With this information a survey should be initiated in areas of concentration in the Spring, looking for spawning concentrations. See buffalo sculpin (F-49).

REFERENCES - A, C, D, E, F, G, H, I, K, 166, 461, 518, 776.

F-54 REDTAIL SURFPERCH

Amphistichus rhodoterus

LIFE HISTORY - Like all *Embiotocidae* (surfperches) the redtail surfperch is ovoviviparous - giving birth to live young (166). No life history information was reported for this species (166, A). They may spawn in summer. See shiner perch (F-56) for general details on surfperch life history.

Migrations are not reported. Food probably includes sand crabs and other small crustaceans (939). In Grays Harbor, they feed mainly on small fish, crabs, and shrimp (G).

This surfperch grows to 16 inches (166), and is an important sport fish species on beaches of the open coast of Washington. They are not exploited by commercial fishermen (K).

WASHINGTON DISTRIBUTION - The northern limit of this species is the central west coast of Vancouver Island (166). The redtail surfperch is not reported in inside Washington waters (C, D). No comparable record exists for the western Strait of Juan de Fuca and coast. They are reported abundant in the surf of Washington's ocean beaches (K). In Grays Harbor this surfperch was taken only rarely during winter and only occasionally during summer in North and South Channels and at Whitcomb Flats (G). In summer, several redtail perch, all females, were taken on the channel side of Moon Island Flats, where they may have been moving to give birth (G). They may be included in "surfperches" in Willapa Bay (E, F). The coastal sand beaches including sand areas off the Columbia River estuary may be the main habitats used by redtail surfperch.

HABITAT REQUIREMENTS - In California this species inhabits shallow surf areas and around old structures. The open water habitat is used but for most of the life stages a bottom association is implied. Fry and juveniles may be more pelagic. Sand areas would be the major bottom type.

CRITICAL HABITAT AREAS - The redtail surfperch has too little known about life history, distribution and abundance in Washington to define critical habitat areas. This surfperch is abundant in the surf along ocean beaches of Washington (K). One area in Grays Harbor - Moon Island Flats (channel side) may be a birth place for redtail surfperch (G). This could indicate coastal bays may be important for this surfperch, but no young were caught there (possibly a sampling problem). The species is not reported in inside Washington waters.

DATA GAPS - Little is known about the redtail surfperch based upon when the information reviewed. A first step would be to summarize past reports of this surfperch in the western Strait of Juan de Fuca (not expected to be there in any numbers) and the open coast. Using any concentrations indicated in that survey, one could begin a sampling program where they appear in large numbers.

Sampling of the surf zone to look for these surfperch may present one of the bigger challenges in filling a marine fish data gap. Standard methods now used may not directly convert to surf zone sampling. Hook and line might be the least complicated but selective. Nets (gill nets) might be usable in calm periods. Beach seines might also be used in calm periods.

Shallow water trawls just beyond the surf zone might supply some surfperch information.

In all seasons, redtail surfperch should be tagged, and specimens that are destroyed should be studied for sexual maturity, age, and diet. When maturity appears, net sampling in and outside the surf zone should be completed with small mesh nets seeking the pelagic fry.

The redtail surfperch should also be brought to the laboratory to look at reproductive behavior, spawning, etc., in captivity.

REFERENCES - A, C, D, E, F, G, K, 166, 939.

FACT SHEET

F-55 KELP PERCH

Brachyistius frenatus

LIFE HISTORY - The kelp perch has a northern limit at Departure Bay (southern British Columbia) and southwest Vancouver Island (166), with only 14 inside water reports (D) and few reported on the open coast (970).

The kelp perch is like all surf perch - giving birth to live young (512). No other life history is stored in the literature survey (A). See shiner perch (F-56) for life history presumed similar to kelp perch. They mature in one year (California) (166). Migrations are not reported. Foods include crustaceans (166, 373).

Kelp perch grow to eight inches and are probably a minor sport fish on the open coast because of relatively low numbers there.

WASHINGTON DISTRIBUTION - Information indicates the kelp perch is a relatively scarce surf perch species in Washington with a northern range limit in southern British Columbia. The inside water catch summary (C), indicates only two areas - San Juan Islands and Colvos Passage with "fewer than ten reports" and the remaining ten subdivisions have no reports. Since then, two Seattle area reports and one Admiralty Inlet report have been documented (D). In all, however, only 14 reports are given for kelp perch in inside waters, with seven from different times at one location - Argyle Bay or Lagoon (D). No comparable record exists for the western Strait of Juan de Fuca and coast.

North Sound beam trawl studies (I) did not capture this species. An ongoing North Sound Study (H), reports the kelp perch an uncommon occurrence in the gravel habitat, in January and September (H).

In Grays Harbor, kelp perch were not taken in the ACOE Study (G). They are not reported for Willapa Bay (E, F) and probably do not inhabit the Columbia River estuary.

HABITAT REQUIREMENTS - The kelp perch utilizes the open water habitat and is reported to be pelagic/bottom-oriented and bottom-associated/subtidal (A). Kelp perch may move up and down in the shallow water areas they inhabit (to 15 fathoms deep, 166) in feeding, but they are thought mostly bottom-oriented as late juveniles and adults. The location of newly hatched fry and younger juveniles is presumed pelagic but the specific location is not reported.

The adult habitat is described as around kelp or characteristically in kelp beds (166). The North Sound Study (H) found them in the gravel habitat.

CRITICAL HABITAT AREAS - With few reported on the open coast (970) and 14 inside water reports, the present information indicates no critical habitat areas for this species, in fact, a question is raised as to why the kelp perch is on a significant marine fishes list for Washington if numbers are as low on the open coast as can be inferred from little data.

DATA GAPS - See redtail surfperch (F-54) for a study plan. Numbers in Washington may not warrant specific research studies.

REFERENCES - A, C, D, E, F, G, H, I, 166, 373, 512, 970.

FACT SHEET

F-56 SHINER PERCH

Cymatogaster aggregata

LIFE HISTORY - The schooling shiner perch is one of the smaller but more numerous surfperch in Washington. Like all surfperch, this species gives birth to live young. Life span is about six years (G). A complicated mating behavior by the males occurs in the breeding season which lasts from May to July in British Columbia (166), May to August in Grays Harbor (G), April to July in the Bangor area (780). Breeding occurs in upper Grays Harbor (218) and sperm is held by the female for five to six months (until November-December) when the eggs are fertilized (21, 166). In the following May through August (peak late June to mid-July in Grays Harbor) five to seventeen (and more, eight to thirty-six in large females) young are born (21, 166). Males are mature at birth while almost all females are gravid in the second year (166). The large hatched fry (5.6 to 7.8 cm, 166) are presumed to move to shallow water areas through late fall and take up the distribution pattern of adults with age.

Migrations are not reported, but this schooling species would be expected to move small distances, while extensive migrations are presumed not to occur.

Foods differ with sex, age, and season (166). The young feed mostly on copepods, with mussels and algae eaten at later stages, and adults are observed eating the appendages off barnacles (166). In Grays Harbor, benthic crustaceans were the main food (G).

Shiner perch grow to about six inches (166), and are too small to interest most sport anglers (K).

WASHINGTON DISTRIBUTION - In British Columbia the shiner perch is common generally in shallow water in Summer and deeper water (to 40 fathoms) in Winter (166). In inside waters the catch summary of shiner perch (C) indicates this to be the most reported surfperch. The shiner perch is reported in 50 or more reports in eight of twelve subdivisions with Strait of Juan de Fuca, Admiralty Inlet and Colvos Passage having "10 to 49" reports and only one area - Georgia Strait, having fewer than ten reports (C). The geographical distribution of these shiner perch reports (D) show large concentrations in parts of all eight areas with 50 or more reports. These concentrations are all over and present no obvious pattern. Deep water areas do not have this species as would be expected (D). A comparable catch summary for the western Strait of Juan de Fuca and coast does not exist.

In the North Sound beam trawl survey (I), this species was not reported and would be expected particularly in East Sound (from historic reports, D). In an ongoing North Sound study (H), the shiner perch was found a common occurrence in mud/eelgrass, sand/eelgrass, gravel and cobble habitats (as shown by beach seine) and similarly in the first two habitats as shown by tow net. Uncommon occurrence of shiner perch was reported for cobble habitat (as shown by tow net) and for rocky/kelp (as shown by trammel net) (H). Shiner perch (adults) were found most of the year in the gravel habitat and in lesser portions of the year in sand/eelgrass, mud/eelgrass, and cobble habitats (H). They were only caught in the rocky/kelp bed area in

December (H). "Juvenile" shiner perch were taken only in April and in the sand/eelgrass and mud/eelgrass habitats (H).

In Grays Harbor (G), winter sampling found the adult shiner perch only present in North Channel where they were common to uncommon. During the Summer, adults were common or abundant in all six study areas but were in greatest abundance in North and South Channels (G). Those taken in the outer harbor were larger than those in the inner harbor areas (G). Juvenile shiner perch were not captured in Winter except for the outer harbor. Some juvenile surfperch identification problems existed in this study (G) but most of the juveniles were thought to be shiner perch.

The shiner perch is probably similarly abundant in Willapa Bay although not specifically named there in recent surveys (E, F). The shiner perch may also be in the lower Columbia River estuary.

HABITAT REQUIREMENTS - The shiner perch uses the open water habitat and is bottom-associated. It is a schooling fish, abundant in shallow waters from late Spring through late Fall, apparently moving to deeper water in Winter (K, 780). This species is abundant along sandy shores, in bays and estuaries during Summer and moving to deeper waters (10 to 40 fathoms) during Winter (776, 533). It has been taken to 70 fathoms (166). The shiner perch is found in shallower water at night and in mid-water at night in the Summer and Fall (93).

Bottom associations seem to occur with a wide variety of bottom types as indicated in one North Sound Study(H) where this species was in all five habitats although not in the rocky/kelp bed habitat but for one month, April, indicating a possible nursery area use of these habitats. Bottom types in the literature survey (A) include pulpy peat, sand/medium, silt, sand, solid rock, mixed: medium, and eelgrass.

The shiner perch (adults) appears to lack a preference for any bottom type or just is not that bottom-associated. Juveniles were located in North Sound only in the mud/eelgrass and sand/eelgrass habitats which may be nursery areas for a short period, as a large fish is born to shiner perch.

CRITICAL HABITAT AREAS - The shiner perch has quite a bit of life history information and is abundant all over inside and probably all over outside waters, 40 fathoms to the low intertidal.

The general habitat types of sand/eelgrass and mud/eelgrass appear as potential critical habitat types, but specific areas are not noted and probably include most eelgrass areas in inside waters and in coastal bays. Additional studies might locate some areas where shiner perch are in large abundance consistently year after year. Critical areas may exist but can not be located except in the general sense of naming the habitat types.

DATA GAPS - See redtail surfperch.

REFERENCES - A, C, D, E, F, G, H, I, K, 21, 93, 166, 218, 533, 776, 780.

FACT SHEET

F-57 STRIPED SEAPERCH

Embiotoca lateralis

LIFE HISTORY - The striped seaperch occurs throughout Puget Sound and in protected bays along the outer coast (K). Like other surfperches, this species gives birth to live young. The life history may be patterned after that of shiner perch (F-56). Little is reported for striped seaperch. They breed from April to July (Bangor area) (780) and young are born 10 to 12 months later (June and July in British Columbia, 166). As many as 44 young have been found in one female (166).

Migrations are not reported but are not expected to be extensive. Food items include small crustaceans, worms, mussels, and herring eggs (166); material cropped from piles and rocks is reported (940).

The striped seaperch grows to 15 inches (166) and is an important marine sport fish in Washington.

WASHINGTON DISTRIBUTION - The striped seaperch is reported "not uncommon" in British Columbia (166) and throughout Washington's Puget Sound and in protected bays along the outer coast (K). In inside waters, it is the third most reported surfperch, behind shiner perch (F-56) and pile perch (F-59) (C). In the catch report summary (C), the striped seaperch has "50 or more reports" in five areas - Central Puget Sound, Port Orchard, Seattle area, Colvos Passage, and South Puget Sound and no reports in Georgia Strait. The remaining six areas have intermediate numbers of striped seaperch reports. The geographical distribution of these inside water reports (D), show concentrations in Tacoma Narrows, Port Orchard, Port Madison, Alki Point and

West Point-Shilshole Bay. No comparable record exists for the western Strait of Juan de Fuca and coast.

The striped seaperch was not taken in a North Sound beam trawl survey (I). In an ongoing North Sound study (H), this species was reported an uncommon occurrence in the following habitats: gravel (as shown by beach seine), mud/eelgrass (as shown by tow net) and rocky/kelp bed (as shown by trammel net). They were observed as a common occurrence in the latter habitat using SCUBA (H). The rocky/kelp bed habitat had striped seaperch in most months except June to August, November and April (H). They were caught in the mud/eelgrass habitat only in September (in two years) and in the gravel habitat in December and July (H).

In Grays Harbor, striped seaperch were thought uncommon (G). This species was not specifically described in Willapa Bay, but may also be uncommon there. The outer Columbia River estuary may also have some striped seaperch.

This species is not described in sandy open coast surf beaches and is presumed absent or in low abundance except where rocky headlands, jetties, etc., are in the sand areas.

HABITAT REQUIREMENTS - The striped seaperch uses the open water habitat type but is bottom associated or "structure associated" most of its life. This species is found in shallow waters during the summer months and usually seen around pilings (780, 940). Another source (K) indicates the shallow water use is longer (late spring through early winter), apparently with retreat to deeper waters during the late winter through early spring. A preference for areas with profuse growths of barnacles and mussels as well as eelgrass beds is noted (K). Bottom types in the literature survey (A) are pulpy peat, sand/medium, sand,and mixed medium.

The North Sound Study (H) found this species in most of the year the rocky/kelp bed habitat with scattered reports in the gravel and mud/eelgrass habitats.

Juvenile striped seaperch may also use the sand/eelgrass, mud/eelgrass areas, like the shiner perch (F-56) but this was not reported.

The newly born juveniles may be pelagic for some period, but this also is not reported.

CRITICAL HABITAT AREAS - Little life history information was reported for this species. It is reported over a wide area in shallow waters. Much used areas are pilings, making this fish species somewhat unique by their good use of man's byproducts (pilings, etc.).

No critical areas stand out from the information reviewed.

DATA GAPS - See redtail surfperch (F-54).

REFERENCES - A, C, D, G, H, I, K, 166, 780, 940.

FACT SHEET

F-58 WALLEYE SURFPERCH

Hyperprosopon argenteum

LIFE HISTORY - The northern limit of walleye surfperch is southern British Columbia (Esquinalt Harbor) (166) and none are reported in inside waters (C, D). Life history information is limited. The pattern of shiner perch (F-56) may hold for this perch. Like all surfperches, live young are born. In California, schools break up, pairs form, and mating occurs from October through December (939). After at least five to six months' gestation, five to twelve young (depending on the female's size) are born (939, 166). Maturity is reached the following Fall and Winter in California (939).

Migrations of any magnitude are not expected. Foods include small crustaceans (939).

The walleye surfperch grows to 12 inches (166) and is probably a minor sport fish due to apparent small numbers in Washington.

WASHINGTON DISTRIBUTION - This is not apparently a very numerous species in Washington. None are reported for inside waters (C, D). No comparable summary exists for the western Strait of Juan de Fuca and coast. They are reported present in these two areas (373).

A few walleye surfperch were taken in gill nets in the Grays Harbor Study (G) and they are felt to be there in small numbers and uncommon within the Harbor.

HABITAT REQUIREMENTS - In California this is probably the most abundant perch of the open rocky coast, preferring sand patches around rocks and similar solid objects (939). Dense schools are reported in California. In California, most of the population is in one to four fathoms (939). This species uses the open water habitat but is bottom associated. The walleye surfperch in the Pacific Northwest is bottom associated on sand/very coarse bottoms (A). This species utilizes very shallow waters. Specific Washington habitat is not described.

CRITICAL HABITAT AREAS - No areas can be defined for the walleye surfperch with the limited data located for them. If this surfperch is not more abundant than indicated for the open coast and Strait of Juan de Fuca ("present", 373), a question would exist as to whether the walleye surfperch is a significant marine fish in Washington.

DATA GAPS - See redtail surfperch (F-54). Specific research targeted on this species may not be warranted if they are not abundant in outside waters.

REFERENCES - A, C, D, G, 166, 373, 939.

FACT SHEET

F-59 PILE PERCH

Rhacochilus vacca

LIFE HISTORY - The pile perch is the second most reported surf perch in inside Washington waters. Like all surfperch, live young are born. Breeding occurs in July in California (166), and April to July in Bangor (780). It has been assumed that gestation takes about 15 months, but there is conflicting information (166). Ten to 12 months gestation is reported in the Bangor area (780). In British Columbia the young are born in August (166). Location of newly born young is not reported. They may be present in large schools in shallow waters in Summer (780).

Migrations were very limited in an Oregon study (166). Food is primarily mussels (in Canada?) (166). Small invertebrates are reported in Bangor area (780).

The pile perch grows to 17.4 inches (166) and is regarded as a fine sport fish in Washington.

WASHINGTON DISTRIBUTION - The pile perch occupies shallow near shore areas. In inside waters of Washington, a catch summary (C), indicates "50 or more" reports in seven of twelve subdivisions which are all those from the Everett area south excluding Admiralty Inlet and including Hood Canal. The remaining five subdivisions had lesser reports (C). The geographical distribution of these reports (D) shows catch concentrations in Case Inlet, Henderson Bay, Tacoma Narrows, Alki Point, West Point-Shilshole Bay, Port Orchard, Port Madison, Murden Cove, Dabob Bay and off Everett. No comparable summaries exist for the Strait of Juan de Fuca and coast.

A North Sound beam trawl survey (I) did not catch this species, which would have been expected in East Sound, based on past reports. In an ongoing North Sound study (H), the pile perch was found an uncommon occurrence in the mud/eelgrass habitat (as shown by beach seine), in the sand/eelgrass (as shown by tow net) and the rocky/kelp bed (as indicated by SCUBA) and was found a common occurrence in the gravel habitat (as shown by beach seine). The gravel habitat had pile perch in September, November, January, and July, while pile perch were caught in the sand/eelgrass habitat only in September (H). Pile perch were seen in the rocky/kelp bed in December (H).

In Big Beef "Harbor" (Hood Canal), the largest numbers of pile perch were seen in September but by November had disappeared and were not seen again until the next July (533).

In the Grays Harbor study (G), pile perch were taken only in summer and reported common on Whitcomb Flats and uncommon in South Channel. The authors conclude that pile perch are uncommon in Grays Harbor (G). Although not specifically mentioned (E, F), pile perch are probably similarly uncommon in Willapa Bay. The same may be true of the lower Columbia River estuary.

HABITAT REQUIREMENTS - Pile perch use the open water habitat, but are bottom and "structure" associated during most of their lives. Newborn fry may be pelagic, but this is not reported. Pile perch habitat is described as similar to striped seaperch (F-57) although pile perch are a moving, schooling species, often abundant in the intertidal zone at the heads of mud-bottomed bays (K). The pile perch frequents rocky shores and old piers (166).

The North Sound study (H), found this species a common occurrence in the gravel habitat, captured sporadically during the year, and also in mud/eelgrass, sand/eelgrass, and rocky/kelp bed habitats. Bottoms associated with included (A): sand/medium, silt, sand, solid rock, and mixed medium.

The pile perch may prefer rocky shores and man-made structures, but a wider variety of habitats is reported. Like shiner perch (F-56) sand/eelgrass and mud/eelgrass may possibly be important nursery areas but this is not reported.

CRITICAL HABITAT AREAS - No critical areas are apparent for the pile perch. Many shallow mud bays in summer and pile areas and rocky shores could be important for this species, but no areas stand out from the rest. The life history is not greatly understood in the information reviewed.

DATA GAPS - See redtail surfperch (F-54).

REFERENCES - A, C, D, E, F, G, H, I, K, 166, 533, 780.

FACT SHEET

F-60 WHITE SEAPERCH

Phanerodon furcatus

LIFE HISTORY - The white seaperch appears low in numbers in Washington with 14 reports in inside waters (D) and few on the open coast (970). Like all surfperch, live young are born. Life history information was not located. One source (166) lacks a life history section. See the shiner perch (F-56) for a pattern that may be similar for white seaperch.

Migrations were not reported. Food in the literature survey (A) for white seaperch had "no information stored".

The white seaperch grows to 12 inches (166) and is probably a minor sport fish due to relatively low numbers in Washington.

WASHINGTON DISTRIBUTION - Vancouver Island is the northern limit of white seaperch, which are labeled uncommon in British Columbia (166). In inside Washington waters, the catch summary (C) is reported in "fewer than ten reports" in five subdivisions - Strait of Juan de Fuca, San Juan Islands, Bellingham area, Port Orchard and Seattle area and not in the other seven areas. Only 14 reports exist in the geographical summary of white seaperch records (D). Of these, six reports are from off Golden Gardens (Seattle) and four reports are from Bellingham Bay (D). No comparable catch summaries exist for the western Strait of Juan de Fuca and coast.

This species was not taken in recent North Sound studies (H, I). In the Grays Harbor study (G), the white seaperch were reported uncommon in summer on Moon Island Flats (as shown by sled trawl). This species may similarly be located in Willapa Bay, but is not specifically reported there (E, F). The species may similarly be uncommon in the lower Columbia River estuary.

HABITAT REQUIREMENTS - The white seaperch utilizes the open water habitat but is bottom-oriented. The literature survey (A) reports the species is pelagic/bottom-oriented. No bottom types are specified. The white seaperch is most common in sheltered bays (in California?) (166).

From the few inside water catches, bottom types of sand, mixed fine, and mixed coarse could be inferred. The habitat requirements can not be defined for this species with the limited information reviewed.

CRITICAL HABITAT AREAS - No areas are defined for white seaperch as the information reviewed indicates this is an uncommon species in Washington with a northern range limit at Vancouver Island. If numbers are not greater on the open coast than indicated, the significance of this species in Washington waters would be in question.

DATA GAPS - See redtail surfperch (F-54). The information reviewed would indicate specific research on this species is not justified.

REFERENCES - A, C, D, E, F, G, H, I, 166, 970.

FACT SHEET

F-61 PENPOINT GUNNEL

Apodichthys flavidus

LIFE HISTORY - The literature survey (A) has "no information stored" for penpoint gunnel life history. The penpoint gunnel is a shallow water fish species located in the middle and low intertidal (A). In British Columbia pairs of penpoint gunnels have been found coiled around egg masses near low tide in January (166). In Hood Canal (Bangor area), eggs have been found December to February. Juveniles were seen at Point Jefferson in all months (103). Growth is rapid (166). No other life history information was located for this species. An Atlantic gunnel *Pholis gunnelus* is reported to roll the spawned eggs into a half-inch or more diameter ball by curving the body around the egg mass (N). Both male and female take turns guarding the egg mass (N). Another source (M) indicates it is not clear which sex or if both sexes guard the eggs. Often the egg mass and fish may be found in the valves of empty oyster shells or in holes made by boring molluscs in rocks (M). After a period of about a month the larvae hatch to become free-swimming members of the plankton community and after growing to slightly over an inch, they sink to the bottom (N) to take up the bottom-associated life style of adults.

The life history of *P. gunnelus* may be similar to the penpoint gunnel. Migration as free-swimming larvae and juveniles in plankton seems possible. The adults appear territorial and quite sedentary. Foods are reported as small crustaceans and molluscs (166, 373, 780).

The penpoint gunnel grows to 18 inches (166) and is probably an important recreational species to the beachcomber in Washington.

WASHINGTON DISTRIBUTION - The penpoint gunnel in inside Washington waters, as reported in a catch summary (C), has "50 or more" reports in only one subdivision - Seattle area, and has "10 to 49" reports in only two areas - San Juan Islands and Central Puget Sound. Two areas have no penpoint gunnel reports - Strait of Georgia and Hood Canal (C). [Two reports were later made for Hood Canal (D).] The remaining areas in inside waters have less than ten reports of this species (C). The geographical record of these catches (D) shows concentrated reports from West Point to Shilshole Bay, around most of San Juan Island, and smaller concentrations in Port Orchard and Port Madison. These "concentrations" are all close to University of Washington research centers. No comparable record exists for the western Strait of Juan de Fuca and coast.

The penpoint gunnel was not taken in a recent North Sound beam trawl survey (I), as would be expected. In an ongoing North Sound Study (H), this species was of common occurrence in the mud/eelgrass and gravel habitats (as shown by beach seine) and was of uncommon occurrence in the sand/eelgrass habitat (as shown by beach seine) and the mud/eelgrass habitat (as shown by tow net) (H).

In these studies (H), catches in gravel habitat were in May through August and November, mud/eelgrass catches were made in July through September and December, and sand/eelgrass catches were made only in July.

This species was not taken in Grays Harbor (G), nor reported in Willapa Bay (E, F).

HABITAT REQUIREMENTS - The penpoint gunnel uses the open water habitat type, being bottom-associated in the egg, older juvenile and adult stages. Eggs hatch into free-swimming larvae which are pelagic. Vertical movements of adults away from the bottom are presumed uncommon, so that the penpoint gunnel spends most of its life on the bottom. Gunnels (in general) tend to hide under rocks and in crevices and during low tide they are often left exposed but able to survive surrounded by moist sea weed (N). Habitats are in the middle to low intertidal (A) and possibly the shallow subtidal.

In North Sound, penpoint gunnel were found throughout the year in two habitat types - gravel and mud/eelgrass (H). Sand/eelgrass catches were limited to July (H). Bottom types in the literature survey (A) are mixed coarse, eelgrass and cobble.

CRITICAL HABITAT AREAS - The penpoint gunnel catch summary (C, D) for inside waters show concentrations that appear "research-related" and may not reflect true concentrations. This species is suspected of being scattered throughout these inside waters in shallow water areas with a wide variety of bottom types. This species may also be in the western Strait of Juan de Fuca and north (rocky) coast but no references to its distribution in these places was listed.

Based upon the information reviewed, the absence of life history information and the wide variety of bottom types with which this species is associated, no critical areas stand out for this penpoint gunnel.

DATA GAPS - If the information reviewed is representative, little is known about this species' life history, distribution and abundance in Washington. A first effort would be a catch record compilation for the western Strait of Juan de Fuca and coast to see if they are located there. They would be expected in the Straits and the north coast because they are reported on the west coast of Vancouver Island (166).

Surveys should be initiated in December through February in all shallow waters of past records and in other areas with appropriate substrate. These surveys should be completed in the mid to low intertidal in standardized sample areas to yield density of adult gunnels. Plankton surveys should be completed in the vicinity of large spawning populations to better define the vertical and horizontal distribution of ths gunnel's larvae and young juvenile states in the water column. Diet should be ascertained in all sizes of fish captured. Quarterly sampling of adults should be completed to detect any density changes with season. Laboratory observations might also be useful.

REFERENCES - A, C, D, E, F, G, H, I, M, N, 103, 166, 373, 780.

FACT SHEET

F-62 SADDLEBACK GUNNEL

Pholis ornata

LIFE HISTORY - Little life history information was located for this species. One source (166) has no section for life history. In the Bangor area reproducing adults and eggs are reported in December-February (780) while on Moon Island (Grays Harbor) a few reproducing adults are reported from May to October (218). (They usually spawn near mouths of streams on muddy bottoms at depths between 10 and 20 fathoms.) The saddleback gunnel eggs are presumed to hatch in about a month and form free-swimming larvae, returning to the bottom at slightly over an inch long (as described for *P. gunnelus* in the life history of penpoint gunnel (F-61).

Migrations as pelagic larvae and young juveniles may be extensive. Movements of adults are probably very limited, although they apparently moved off a sampling area in Grays Harbor in Winter. They are reported to eat mainly molluscs and small crustaceans (166, 373, 780), but Grays Harbor gunnels feed mainly on *Annisogammarus* sp. (G).

The saddleback gunnel grows to 12 inches (166) and is probably a minor recreational species to beachcombers in Washington.

WASHINGTON DISTRIBUTION - In inside Washington waters, the saddleback gunnel catch record summary (C) indicates no "50 or more" report areas and no reports at all from the Bellingham area. Four areas have "10 to 49" reports - San Juan Islands, Admiralty Inlet, Seattle and South Puget Sound with the remaining seven areas having fewer than ten reports (C).

The geographical distribution of reports of saddleback gunnel indicate small concentrations in Friday Harbor, Griffin Bay, and West Point-Shilshole Bay (D), which may be "research-related concentrations". The remainder of the records are scattered throughout the shallow inside waters. No comparable catch summary exists for the western Strait of Juan de Fuca and coast.

A North Sound beam trawl did not capture this species (I). An ongoing North Sound Study (H) found saddleback gunnel in all habitats as follows:

Common occurrence in mud/eelgrass and gravel (as shown by beach seine).

Common occurrence in mud/eelgrass and sand/eelgrass (as shown by tow net).

Uncommon occurrence in sand/eelgrass and cobble (as shown by beach seine).

Uncommon occurrence in gravel, cobble, and rocky/kelp bed (as shown by tow net).

The saddleback gunnel was found: in the mud/eelgrass habitat in June-December and May; in the gravel habitat in June-September, November, December, and April; in the sand/eelgrass in July-September; in the cobble in March, August and September; and in the rocky/kelp bed in April, December and July (H).

In Grays Harbor (G) this gunnel was not taken in Winter, but in Summer was found in all harbor areas sampled. They were found abundant at Mid-Harbor Flats and Moon Island (where they were most numerous in the northern part where vegetation was more dense). In upper Grays Harbor, saddleback gunnels were most common from May to mid-October when salinities in that area are highest (218).

Although not mentioned (E, F) saddleback gunnel probably exist in Willapa Bay as they do in Grays Harbor.

<u>HABITAT REQUIREMENTS</u> -The saddleback gunnel uses the open water habitat but is bottom-associated most of its life (in the egg stage - presumed attached, the late juvenile and adult stages). The newly hatched larvae and early juvenile are pelagic in Grays Harbor (218) and are described as surface/mid-water (A).

The bottom association occurs most frequently near the outlets of streams on muddy bottoms at deptsh of 10 and 20 fathoms (166). Middle and low intertidal positions are also reported (A). Bottoms with abundant vegetated (algal) areas are preferred (G). Associated bottoms types include: boulder, mixed: medium, eelgrass, cobble, pebble-sand, sand, sand/fine, clay, silt, and mixed coarse (A). They are reported to be found under rocks (205).

In North Sound Studies (H) all habitats were used although saddle-back gunnel were captured in rocky/kelp bed hatitat in only one month.

This species may prefer being near the mouths of streams on muddy bottoms (166), but it appears to utilize a wide variety of bottom types from the information reviewed.

The preference for low salinities is implied by some sources (166, 780) and the opposite is stated by another source (218) for upper Grays Harbor.

The habitat requirements of the saddleback gunnel appear to be quite varied, indicating a fairly adaptable shallow water (subtidal to mid-intertidal) fish species.

CRITICAL HABITAT AREAS - Little life history information was located for the saddleback gunnel and habitats used in a bottom association seem quite varied. No significant patterns of distribution were located. No areas were defined.

DATA GAPS - See penpoint gunnel (F-61).

REFERENCES - A, C, D, E, F, G, H, I, 166, 205, 218, 373, 780.

F-63 CRESCENT GUNNEL

Pholis laeta

LIFE HISTORY - No life history was located for crescent gunnel. One source (166) has no life history section, while the literature review (A) describes habitats briefly. For a general pattern of gunnel life history see F-61 and F-62.

Migrations could be similar to that postulated for gunnels F-61 and F-62. Food of crescent gunnels includes small crustaceans and molluscs (780).

The crescent gunnel grows to 10 inches (166) and is probably an important recreational species to beachcombers in Washington.

WASHINGTON DISTRIBUTION - In British Columbia this gunnel is common to depths of 30 to 40 fathoms and into the intertidal zone (166). In inside Washington waters catch reports (C), the crescent gunnel was found in all subdivisions and had "10 to 49" reports in four areas - San Juan Islands, Central Puget Sound, Seattle area, and South Puget Sound. All remaining areas had "fewer than ten" reports (C). The geographical location of these reports (D), is much the same as saddleback gunnel (F-62) - concentrated reports off West Point-Shilshole Bay, Friday Harbor and Griffin Bay. The "concentrations" may be "universally related". No comparable catch summary exists for the western Strait of Juan de Fuca and coast.

No crescent gunnels were reported from a North Sound beam trawl survey (I), nor from East Sound, where they have been reported (D). In an ongoing North Sound study (H), crescent gunnel was reported as a common occurrence in only one habitat - gravel (as shown by beach seine).

All other habitats - sand/eelgrass, mud/eelgrass, cobble, and rocky/kelp bed had this gunnel as an uncommon occurrence (as shown by tow net) (H). The crescent gunnel was captured in the gravel habitat in all months except September and February-April (H). This species was captured in the mud/eelgrass habitat in December, February, March and April and in the sand/eelgrass habitat in July-August, December and March (H). This gunnel was caught in the cobble habitat in April-May, July and December and in the rocky kelp bed in December and March (H).

This species was not taken in Grays Harbor (G) and is not reported in Willapa Bay (E, F).

HABITAT REQUIREMENTS - Crescent gunnel have a wide depth range compared to other gunnels - 30 to 40 fathoms to the mid-intertidal (166, A). The species uses the open water habitat, but is bottom-associated in most life stages (egg - presumably attached, older juveniles and adults). Pelagic fry and young juveniles are presumed as noted for saddleback gunnel (F-62).

Crescent gunnel are frequently found in the intertidal area in tide pools or under rocks protected by seaweed (166, 205).

All habitats were used to some extent in the North Sound tudy (G). Bottom types associated with include: mixed coarse, pulpy peat, boulder, cobble, pebble-gravel, solid rock, and kelp (A).

This species (like saddleback gunnel, F-62) seems to use a wide variety of bottom substrates, thus exhibiting a great deal of adaptation. No bottom type stands out as the most important.

CRITICAL HABITAT AREAS - Little life history data and a wide variety of bottom types used prevents the definition of specific critical habitat areas.

DATA GAPS - See penpoint gunnel (F-61) and add shallow water trawling and SCUBA observation to depths of 30 to 40 fathoms.

REFERENCES - A, C, D, E, F, G, H, J, 166, 205, 780.

FACT SHEET

F-64 QUILLBACK ROCKFISH

Sebastes maliger

LIFE HISTORY - Little life history was located for this rockfish. One source (166) has no section for life history. Like all rockfishes, the quillback is ovoviviparous - giving birth to live young (166, 780). Young are born in the Summer months in the Bangor area (Hood Canal) (780). No other life history information was located. Fry and young juveniles are presumed pelagic with an increasing bottom orientation with age, as for black rockfish (F-29), or copper rockfish (F-26). Vertical migrations may occur in feeding.

Migrations were not reported but pelagic stages (fry and young juveniles) could be expected to move some distances from the place of birth. Foods include fish (including herring) and invertebrates (especially crabs) (780).

The quillback rockfish grows to 24 inches (166) and is one of the most common rockfish in sport catches in Washington (K).

WASHINGTON DISTRIBUTION - In the northern part of this species' range (including British Columbia and Washington?), the quillback rockfish is in inlets and shallow rockpiles, while in California it is taken to 150 fathoms (166). In inside waters of Washington, the catch summary (C), has "50 or more" reports of quillback rockfish in San Juan Islands and the Everett area, with no reports in Georgia Strait and Admiralty Inlet. The majority of the remaining subdivisions have "10 to 49" reports (C). The geographical distribution of these reports (D) show concentrated reports off Shilshole Bay.

Appletree Cove and Sucia Island. Scattered records are indicated in Possession Sound, Port Susan, Saratoga Bay (D). No comparable catch records exist for the western Strait of Juan de Fuca and coast.

In the North Sound beam trawl survey (I), this species was not reported. In an ongoing North Sound Study (H), quillback rockfish were a common occurrence in the rocky/kelp bed habitat (as shown by SCUBA) and an uncommon occurrence in the gravel habitat (as shown by beach seine). The quillback rockfish was present in the gravel habitat only in one month - October, while it was seen in the rocky/kelp bed habitat most of the year (excepting October-November, and April-June) (H).

This species was not reported in Grays Harbor (G) or specifically in Willapa Bay (E, F).

HABITAT REQUIREMENTS - The quillback rockfish uses the open water habitat type, but is bottom-associated from the late juvenile through adult stages. The fry and young juveniles are presumed pelagic as they are in related rockfish (A).

In British Columbia, the quillback rockfish is in inlets around shallow rock piles (166). The Washington habitat is described as usually restricted to rocky bottoms below eight fathoms (48 feet) and can be on rocky reefs in strong tidal current areas (K). These descriptions seem to fit many of the catch reports (D) but do not seem to fit the deeper mud bottomed areas where reports are scattered (i.e., Saratoga Passage, Bellingham Bay, etc.). The majority of the records (D) as well as the North

Sound study (H) do place this species in a rocky/kelp bed or general hard bottom area. The only substrate in the literature review (A) is solid rock.

CRITICAL HABITAT AREAS - Too little life history information exists to decide on the criticality of areas in which this species may be located. Concentrated reports are seen in inside waters, but a fairly varied bottom association is implied by other scattered reports. This species of rockfish does not appear to easily fit in a habitat category. The generalizations of inlet areas and shallow rockpiles may not fit some of the reported areas of capture. The species is also described as "one of the most common rockfishes in sport catches" (K). Another source indicates the quillback rockfish is similar to the copper rockfish (F-26) (J).

No areas stand out for the fairly common and well distributed rockfish species. No areas are designated as critical.

DATA GAPS - See copper rockfish (F-26) and black rockfish (F-29).

REFERENCES - A, C, D, E, F, G, H, I, J, K, 166, 780.

FACT SHEET

F-65 AMERICAN SHAD

Alosa sapidissima

LIFE HISTORY - The American shad is an introduced anadromous species brought from the Atlantic to the Sacramento River in 1871 and to the Columbia River in 1886 (J). The Pacific Coast center of abundance is now between San Francisco Bay and the Columbia River. The shad matures in four to five years (five to six years, J) and has a fecundity as great as 150,000 eggs/female (166). The fish spawn in the lower reaches of larger rivers in late spring (166). In the Columbia River this extends to the Bonneville Dam vicinity.

The fish spawn at night with eggs extruded near the surface in small numbers (J). The eggs sink upon fertilization lodging in the bottom, in crevices, or upon vegetation (J). Incubation takes three to six days (J), about a week (166), ten days in the Chehalis River (218). The young drift downstream by September (Atlantic Coast) or much sooner (166). In the Chehalis River, fry have been seen in upper Grays Harbor from July to November with peak abundance in August through October (218). Young shad apparently use the estuary and bay (Grays Harbor) as a nursery area before entering the open ocean. A few small shad (68 to 74 mm) were taken in Grays Harbor in the Summer (G).

Migrations are reported as "not far", but the spread of shad on the Pacific Coast is good evidence of substantial movement (166). The food at sea consists mainly of crustacean plankton but fishes are sometimes taken (166).

WASHINGTON DISTRIBUTION - The greatest numbers of shad "in Washington" are in the Columbia River with vast numbers (about 1.5 million annually) in the lower river from May through August (Q). they arrive at Bonneville Dam in June and July (Q).

Runs of fishable size have also become established in the Chehalis and Willapa Rivers (Q). Shad are in the Chehalis River from May through the Summer months and ascend the river at least as far as the Skookumchuck River near Chehalis (Q). In the Willapa River, shad occur in the estuary of the lower river during late Spring and Summer months (Q). They move through Willapa Bay in late Spring and early Summer on their way to the Willapa River (main area) but also utilize the Palix, North, and Nasselle Rivers (E). The Columbia, Chehalis, and Willapa Rivers appear to have the main runs of American shad in Washington.

In inside Washington waters, the summary catch survey (C) lists "50 or more" reports in one area - Everett (including the Skagit River delta). Three areas - Strait of Juan de Fuca, Bellingham area, and Seattle area have "10 to 49" reports (C). Georgia Strait had no reports while the remaining seven areas had "fewer than 10 reports" (C). The geographical distribution of these inside water catches (D) shows the bulk of the reports from Skagit Bay and Port Susan with fewer reports from Everett (Snohomish estuary) and the coastline from Shilshole Bay to Edmonds.

The Skagit River is the only river in inside waters with a described sport fishery and "some" shad enter the Skagit River (Q). The geographical distribution (D) indicates some shad may also enter the Snohomish River.

HABITAT REQUIREMENTS - The American shad is a unique anadromous fish in Washington because it was introduced and because it is not apparently in all river systems (yet) that seem inhabitable (i.e., Nisqually River) unless requirements are more specific than seems apparent.

Little is known about the marine distribution of the shad off the Pacific Northwest Coast (K). The implication is that they do not move far from the river mouths or bay mouths. This appears to be the case for "inside water" reports.

The marine and estuarine habitat of American shad therefore is an area associated with a larger river system usually of low gradient in its lower reaches that has an extensive estuary or bay. The known river systems have been described. The remaining records are probably straying fish which, if abundant enough in a proper habitat area, may become better established. The river system, estuary, and bay may have to have other optimal parameters, but this can not be defined from the information reviewed and may not be known.

CRITICAL HABITAT AREAS - If a criteria of importance for an introduced species is expansion of existing range or the protection of existing range, critical areas could be assumed those where this species is apparently doing some range expanding. Critical habitats may exist for American shad in the large Columbia River system or in the adjacent ocean waters, but no information was located to define these areas. The Willapa, Chehalis, Skagit Rivers, and possibly the Snohomish River, appear to have smaller populations of American shad which should be protected, therefore the estuaries of these rivers are coded (F-65) to denote their importance to upstream adults and downstream fry in areas where shad are expanding or sustaining their population.

DATA GAPS - The biology of "inside water" shad and the marine distribution of shad particularly on the open coast is not described. These aspects of the shad's life history and marine distribution should be studied using gear from gill nets to trawls to locate them and to proceed with tag and recovery programs in fresh and salt water. Fishermen's assistance should be requested for tag returns. Fish killed in sampling should be studied for stage of maturity, age, and diet.

A catch record of shad for the western Strait of Juan de Fuca and coast should be initiated to provide direction to the marine sampling program.

REFERENCES - C, D, E, G, J, K, Q, 166, 218.

FACT SHEET

F-66 PACIFIC HERRING

Clupea harengus pallasi

LIFE HISTORY - The Pacific herring, while directly an important fish, is probably even more important as a food fish in the diet of many other fish species. This importance is reflected in the volume of life history data reported (A, 166). These sources should be reviewed for more specific details than will be presented here.

The Pacific herring lives for eight years (J), matures in two to four years (21) with fecundity ranging from 9,000 to 38,000 eggs/female in British Columbia (166). Spawing occurs in mass activity (no evident pairing) in the Winter and early Spring varying by area. Location of spawning is depth-related in North Sound as subtidal spawning occurs in January-March, and intertidal spawning in April and May (725, 975). Southern Puget Sound, Hood Canal and most of the Puget Sound basin (except North Sound) have subtidal spawning (975). Spawning usually only lasts about two weeks in any one area (780). Eggs are adhesive and are attached to eelgrass, marine algae, pilings, oyster dykes, live oysters and other objects found in sheltered bays (J). Eggs are deposited from the upper limit of high tide to a depth of five to six fathoms (J, 166). The main spawning occurs from the intertidal zone to a few feet below mean low water (J). Eggs hatch in about ten days, depending on temperature (166). A period as long as 14 to 18 days is reported (J, 138). Spawing mortaility is heavy (56 to 99 percent) depending on wave and air exposure (6). The larvae are about one-quarter inch long (J) and occupy surface waters for about two months before transforming into juveniles (776). The first six months of life is the limiting survival factor (166). Juveniles progress to the adult stage at about three months and at about a year are close to four inches and beginning to be sought in the bait fishery (J).

Pacific herring appear to have an annual migration from inshore spawning grounds to open ocean feeding areas as relatively few remain in Puget Sound the entire year (J). Adults also make vertical migrations being located at 30 to 35 fathoms during the daytime and feed at seven to fifteen fathoms at night (166, 975). Depth changes also occur with age. In southern Hood Canal, juveniles are found at eight to ten fathoms, while adults are below fifteen fathoms (975). Even though migrations are made, homing occurs (21) and restricted mixing is confirmed by tagging (166).

Foods are as follows (166):

Larvae - invertebrate eggs, copepods, and diatoms

Post Larval - ostracods, small copepods and their nauplii, small fish larvae, diatoms

Larger Young - copepods, amphipods, cladoceraus, decapods, barnacle larvae, euphausiids

Adults - larger forms of crustaceans and small fish (eulachon, herring, starry flounder, ronquil, sand lance, hake, marble sculpin, and rockfish).

Pacific herring grow to about 13 inches (166) and are an important commercial species. Sports fishermen will fish for this species usually to provide bait for other fishing.

WASHINGTON DISTRIBUTION - The Pacific herring is very abundant in all Washington waters in this study with the exception of the Columbia River estuary. In inside waters "50 or more" reports exist for all 12 subdivisions (C). The geographical distribution of these reports (D), shows records all over these waters, but generally closer to shore and not numerous in open waters of southern Hood Canal, central Puget Sound, Admiralty Inlet, and Strait of Juan de Fuca. This is not to say they are not there, as they must travel through these areas going to and returning from outside waters.

The North Sound beam trawl survey (I) did not report this species. Pacific herring (juveniles) were reported a common occurrence in all five habitat types in the ongoing North Sound study (H). Juvenile herring were seen in most habitats in most of the year, although herring were not captured in some habitats in November-March (H). They were taken in all habitats in June-September (H) with concentrations in protected embayments. Larval herring were also seen in all habitats from April to July (H). Sand/eelgrass and cobble habitats also had juvenile herring in December to February (H).

In Grays Harbor studies (G), Pacific herring were taken occasionally in small numbers in North Channel during winter. In summer, herring were most common at the outer Harbor, indicating these fish are part of a larger population which exists largely outside the Harbor.

In Willapa Bay (E), herring use the Bay as a spawning and nursery ground, spawning in January and February and producing immature herring that are found in the Bay during spring, summer and fall.

The use of the Columbia River by Pacific herring was not reported in the information reviewed.

HABITAT REQUIREMENTS - Pacific herring uses the open water habitat, but unlike most marine fish, is bottom-associated in the egg stage and promptly becomes pelagic although bottom-oriented for the first six months to a year of life. From that stage to adulthood, the habitat is pelagic/mid-water to near surface. A bottom association recurs briefly in two to three years as the adult spawns for the first time.

Larvae and juveniles are found in shallower waters of bays and inlets (475) and, as indicated in a North Sound study (H), have a wide latitude in their use of bottom habitat types. A general pattern of movement is as follows (979):

> Pacific herring feed offshore above the continental shelf in summer and fall. Adults move inshore in fall and spend the winter in inshore schools. They spawn in the spring. After hatching and the larval stage, two-month old juveniles form schools in June-October, remaining inshore in kelp. This is followed by an offshore migration with a return to inshore waters at three years of age.

Substrates used for spawning are primarily eelgrass and algae (978) but many other natural and artificial substrates are used (i.e., rocks, piling, trash, 166).

CRITICAL HABITAT AREAS - Pacific herring are abundant and widespread in Washington waters. The biology of this species, unlike most marine fish, is fairly well understood as indicated by all the information on this species.

The center of spawning activity in southern Puget Sound (inside the Tacoma Narrows) appears to be Totten Inlet. Studies are on-going concerning the early life history of herring in this region, as well as a great deal of acoustic stock assessment work. The scantiness of marina vegetation in Totten Inlet during the spawning season leads one to suspect that the spawning fish are perhaps using cultivated oysters for substrate.

The high abundance of larvae, compared to that found around other Puget Sound spawning grounds would indicate, however, that several hundred tons of adult herring are probably present annually.

Other small and inconsistently used spawning areas in southernmost Puget Sound occur in the vicinity of Hope Island, Johnson Point, and Mayo Cove in Carr Inlet.

Between Tacoma and Everett the major herring spawning area lies within Quartermaster Harbor, where several hundred tons of spawners are involved annually. A somewhat smaller but very significant stock spawns in northern Port Orchard. The Port Madison spawning stock appears to be at a rather low level and spawning is inconsistent. Reports of herring spawning activity in the immediate area of the Bremerton Naval Shipyard have not been confirmed.

Hood Canal holds three major spawning populations. In southernmost Hood Canal, herring spawn consistently from Lynch Cove to Twanoh State Park. Herring spawn in the Dabob Bay area, but as yet it appears that only Quilcene Bay is consistently used. The largest spawning population of the three may be the Port Gamble stock.

Sequim Bay supports a small spawning stock. Knowledge of the herring spawning in Discovery Bay is still incomplete and needs more extensive survey effort. In Port Townsend herring spawn consistently north of Kala Point with the Indian Island shore being used intermittently. Much of the shoreline of Kilisut Harbor has been found to be used by spawning herring on one occasion or another in the last five years. The Mystery Bay area seems most consistently used.

Within the Island - Skagit County area, the Holmes Harbor stock, formerly of great significance, is now apparently at quite a low level. Herring have been found to spawn rather consistently in the area between Goat I. and Hope I., with more intermittent use of Similk Bay. Small stocks also use the Fidalgo Bay and eastern Samish Bay area on an annual basis.

The Whatcom County area probably supports the largest herring spawning stock in the State. Most of the marine shoreline of the county has been documented as spawning ground at one time or another during the past five years. The area receives two distinct spawning runs, separated by about 1½ months. The second run is much larger (several thousand tons) and supports the State's only herring roe fishery. Some of the areas utilized most consistently by spawning herring include the Pt. Francis area, the west shore of Hale Pass south from Pt. Migley, the area from Cherry Pt. to Pt. Whitehorn, Birch Pt. the entire shore of the Drayton Harbor spit, and the northwestern shore of Point Roberts. The spawning activity also extends up into the Canadian waters of Boundary Bay. Although in nearly all the spawning areas to the south spawn-deposition intensity is generally "very light", it is not uncommon to find considerable areas of "medium" or "heavy" spawn deposited in theGulf of Georgia during the later spawning run.

The San Juan archipelago is the area for which knowledge of herring spawning stocks is most incomplete. Some small stocks are known to spawn consistently in the Mosquitoe Pass - Westcott Bay - Garrison Bay area on San Juan Island, in southernmost Lopez Sound, northernmost East Sound and the West Sound area. Other small spawning areas also have been recently found in the Shaw Island area by U.S.F.W.S. workers. Most of the area remains largely unexplored. The ability of spawning herring to use a great variety of shoreline types, from steep rocky shores to broad mud flats, indicates that virtually all of the shoreline in the archipelago is at least potential spawning area. It is unlikely that undocumented spawning areas are consistently very large, or their presence would have been a matter of historical record (X).

Carr Inlet in South Sound is mentioned as having the largest numbers of herring in winter (725). Strait of Georgia may be a focus point of herring that spawn elsewhere in Puget Sound. In North Sound, a deep depression just east of Eliza Island is mentioned as having great numbers of herring (725). Bellingham Bay and the area between Lummi Bay and Point Roberts are postulated as important migration areas (725).

Herring may spend their first 2 years of life in the Puget Sound area, providing forage for many marine species and providing the basis for commercial sport salmon bait fisheries in various parts of Puget Sound. The recruiting subadults and mature adults are thought to make annual migrations between the Banks off the mouth of the Strait of Juan de Fuca and their various spawning grounds. Maturing herring begin to appear in inside waters in late fall and winter, some months before their spawning activity commences. Each geographically and temporally distinct spawning run should be considered a distinct race, subject to localized extinction, although the mixing of drifting larvae and schools of juveniles probably results in continuous genetic exchange (X).

DATA GAPS - The life history is quite well understood. However, tag and recovery information would be required to answer questions about movement. Catch summaries should also be completed for the western Strait of Juan de Fuca and coast.

REFERENCES - A, C, D, E, G, H, I, J, X, 6, 21, 138, 166, 475, 725, 776, 780, 975, 978, 979

FACT SHEET

F-67 NORTHERN ANCHOVY

Engraulis mordax

LIFE HISTORY - The common name of this species is deceiving, as the northern limit of this species is the Queen Charlotte Islands with a center of abundance at San Francisco and south, and an apparent preference for water temperatures of 14.5 to 18.5 C (166).

The life span of the northern anchovy is variously reported - four years (21), six years (263), and seven years (166, 325, J). Maturity is reached at two to three years by half of the anchovies and all are mature by four years (166, 325, J). Spawning can occur during all periods of the year (21), but peaks in winter and spring (263). Spawning is reported from May to August in open Washington waters (J). Fecundity is reported as 20,000 to 30,000 eggs/female/year (325). Multiple spawnings occur - two and three times/year/female (166, 325, 780). Northern anchovy spawn both in the open ocean and in protected bays like Grays Harbor (G). Spawning occurs from 90 km offshore to shore (21). Fertilization is external (166) and is extremely successful (325), however, high egg mortalities occur (97).

Spawning by small numbers (10+) of northern anchovy was reported in mid-Dabob Bay and Saratoga Passage in summer, 1971 (D).

Eggs drift about two to four days before hatching and larvae produced are less than one-quarter inch long (J). Young anchovies metamorphose into the adult form at about one inch in length (J).

No north-south movements are known (21), but the northern anchovy does tend to be more offshore in the fall/winter and inshore during the spring (21, G, 166, 263, 325). This anchovy also exhibits vertical migrations - surfacing at night and going often to the bottom during the daytime (166).

Anchovies feed by filtering and particulate biting (166). Foods include euphausiids, copepods and decapod larvae (166). Small fish are also reported food organism (325). The anchovy grows to 9.8 inches (166) and is apparently in low enough numbers to not be of commercial importance in Washington.

WASHINGTON DISTRIBUTION - In British Columbia the northern anchovy is not available abundantly or consistently enough to be commercially used at the present time (166). The populations of this anchovy in Washington waters are relatively small (J). This anchovy may constitute a significant portion of the open water fish populations of southern Puget Sound and Bellingham Bay (J).

In inside Washington waters, the catch record summary (C) has no reports for three areas - Georgia Strait, Strait of Juan de Fuca and Colvos Passage, and four areas with "10 to 49" reports - Bellingham area, Everett area, Port Orchard and South Puget Sound. The remaining subdivisions of the inside waters have "fewer than ten reports" (C). Of the limited inside water reports, the geographical summary of the northern anchovy catches (D), show small concentrations in Dabob Bay, Port Orchard, and Carr Inlet. No comparable records exist for the western Strait of Juan de Fuca and Coast.

The North Sound beam trawl survey (I) did not catch this species as might be expected. An ongoing North Sound study (H) found the northern anchovy in common occurrence in the mud/eelgrass habitat and an uncommon occurrence in the sand/eelgrass, gravel, cobble and rocky/kelp bed habitats (all shown by tow net). The timing of catches was as follows (H): Gravel in July, mud/eelgrass in June-August, sand/eelgrass in December, May and July, cobble in July, and rocky/kelp bed catches in June and July.

In Grays Harbor, the northern anchovy was found to be the most abundant smelt/herring-like fish (218). In a more recent survey (G), winter sampling took this anchovy only infrequently in North Channel and not elsewhere in the Harbor, while summer sampling found this species in abundance in all areas except Moon Island Flats and the outer Harbor. In summer, they were the most abundant species (of fish?) taken in North Channel (G). Little size difference was reported among different Harbor areas in summer.

In Willapa Bay (E) the northern anchovy is reported to spawn in the ocean, but be plentiful in the Bay from June through October. Together with Pacific herring (F-66), this anchovy is reported to represent a "latent" resource that could support a significant bait fish fishery (E).

Grays Harbor, Willapa Bay and the Columbia River estuary appear to be important nursery grounds for northern anchovy (J).

HABITAT REQUIREMENTS - Of the fish in this series, the northern anchovy is the first that is totally pelagic in its use of the open water habitat reported as pelagic/midwater or surface in all studies encompassed in literature survey (A). The northern anchovy can utilize shallow water areas for spawning and nursery areas, but the variable bottom type habitats indicate no great preference which in turn probably reflects the pelagic nature of this species. Unlike the Pacific herring (F-66), the northern anchovy does not utilize a a substrate to spawn on. Eggs are concentrated in surface waters (0 to 5 meters) (97). Eggs and larvae have been found 300 miles offshore British Columbia (166). Larvae and juveniles are also reported to utilize inshore nursery areas (263) such as Grays Harbor, Willapa Bay and the Columbia River estuary (J).

Sand/eelgrass and mud/eelgrass were the habitats in which northern anchovy were caught in most months of the year (H). These bottom types may provide protection to northern anchovy from predators. The larger adults appear to be primarily a vertically migrating pelagic species.

CRITICAL HABITAT AREAS - Northern anchovy appears to periodically be abundant in open waters of southern Puget Sound and Bellingham Bay and a few spawners have been observed in mid-Dabob Bay and Saratoga Passage, however, the numbers in inside waters do not appear to be regularly abundant.

The open coast bays - Grays Harbor, Willapa Bay, and the Columbia River estuary are reported to "appear to be important anchovy nursery grounds". These areas apparently have annually abundant quantities of this anchovy and may qualify as critical habitat areas. Unfortunately, no specific areas in these general locations are defined as nursery areas, although during low tide periods they could not include exposed tide flats and would be in channels of Willapa Bay and Grays Harbor. Unfortunately for this study, the specific nursery areas can not be defined and mapped because the information reviewed did not really describe important areas in these general locations.

Based upon the information reviewed, no critical habitat areas are mapped, but apparently exist in Grays Harbor, Willapa Bay and the Columbia River estuary as nursery areas for northern anchovy.

DATA GAPS - A catch summary for northern anchovy in the western Strait of Juan de Fuca and coast of Washington appears to be needed. With this and sources at hand, sampling should focus on concentrations that may be spawning or in nursery areas. Tagging should be completed to assess movements and indicate population sizes in various seasons for several years so that abundances between areas can be better judged and the contribution of inshore populations to offshore populations be estimated.

REFERENCES - A, C, D, E, G, H, I, J, 21, 97, 166, 218, 263, 329, 780.

FACT SHEET

F-68 CHINOOK SALMON (KING)

Oncorhynchus tshawytscha

LIFE HISTORY - The chinook salmon is the largest of the Pacific salmon species. This salmon has been the subject of intensive past and present culturing processes to enhance natural runs with the original efforts beginning in fresh water hatcheries and continuing today and being joined by salt water pen rearing activities in recent times. The life history of this anadromous species is well studied in the fresh water part of the cycle (spawning adults and early life history) and less studied and understood in the estuarine and marine part of the life cycle. This is a data gap that will prevent a full evaluation of the critical nature of habitats this salmon has in the marine and estuarine environments.

In British Columbia, chinook salmon enter spawning rivers during most of the year, generally using larger rivers (166). chinook salmon are widely adapted to the river system they utilize, spawning from just above the tidal limit to as great as 600 miles up larger rivers (166). Two races of chinook salmon are recognized in some rivers. The spring run migrates in late February to June (spawn August through October) and the fall run migrates in July to December (spawn August to December) in the Chehalis River (218). The Columbia has a well defined spring and fall run of chinook salmon. Another "run" is called the summer run, depending on the timing in a specific river.

Males mature at two to five years while females mature at four to five years of age (K). Fecundity is reported as 4,800 eggs/female, depending on her size and strain (166). Mature two-year old male chinook are called "jacks" (K).

Spawned eggs hatch from late winter to spring (218). The adults die after spawning. Young usually go to sea soon after hatching but may remain in fresh water for at least a year (166). Young migrate to sea most heavily in May and June (780). Off the Fraser River, young are found off the mouth from April on (166). The bulk of young spring chinook remain in fresh water for a year or more before going to sea (J).

The fall run chinook are in Grays Harbor from April through June and the spring run are in the Harbor from April to September (G). However, young chinook were also taken in the upper Harbor from January through March (218).

These yearlings enter the sea and stay to the age of maturity before homing back to the natal stream or river system. Migrations are far beyond State waters, into central California and Alaskan waters. Chinook salmon can be in marine and estuarine waters in most months of the year depending on the location of chinook rivers and the waters being evaluated.

A brief tabular summary of the chinook salmon's life history follows (R):

FALL CHINOOK (*Oncorhynchus tshawytscha*), also called king, tyee, blackmouth, and jack salmon.

	SMALL TRIBUTARY	LARGE TRIBUTARY	MAIN RIVER	ESTUARY	OCEAN	GENERAL COMMENTS
Mature Adults (spawning)	Some use	30 to 60 days fall months				Adults always die after spawning.
Eggs & Larvae (incubation)	Some use	90 to 150 days in gravel winter months				Average number of eggs 4,000 per female. Max. 13,500.
Juveniles (rearing)	Some use	60 to 120 days, spring months through summer		30-60 days seaward migration		Limited by loss of natural spawning and rearing areas.
Growth to Maturity					1-5 yrs. 3 yrs typical	Ranges north to Alaskan waters Some Puget Sound proper.
Maturing Adults		Returning to original spawning grounds to complete life cycle, normally at age 4 years.				Average weights 20-25 lbs. 126 lb. maximum weight.

SPRING CHINOOK (*Oncorhynchus tshawytscha*), also called spring salmon, blackmouth and jack salmon.

	SMALL TRIBUTARY	LARGE TRIBUTARY	MAIN RIVER	ESTUARY	OCEAN	GENERAL COMMENTS
Mature Adults (spawning)	Some use	3 to 6 months spring through early fall months.				Adults always die after spawning.
Eggs & Larvae (incubation)	Some use	90 to 150 days--Fall through mid-winter months.				Average number of eggs 4,000 per female. Max. 13,500.
Juveniles (rearing)		Juveniles tend to spend a full year in fresh water.		30-60 days seaward migration		Limited by loss of natural spawning and rearing areas.
Growth to Maturity					1-5 yrs. variable 3 yrs. typical	Ranges north to Alaskan waters Some Puget Sound proper.
Maturing Adults		Returning to original spawning grounds to complete life cycle, normally at age 4 years.				Average weights 20-25 lbs. 126 lb. maximum weight.

Migrations of chinook salmon are quite extensive going south to central California and north to Alaska. In the inner Sound, north of Seattle, chinook salmon originate in Canadian waters, principally the Fraser River, although some Columbia River fish come into North Sound (23). South Sound chinook salmon are usually native, while Strait of Juan de Fuca fish originate in the Columbia River (23). Coastal Washington fish are primarily Columbia River fish, although migrating fish from coastal bays, other states, and British Columbia, would also be in the area. chinook salmon from the Washington coast primarily migrate north (539).

Foods of young chinook salmon include small fish (sand lance, eulachon, herring, rockfish, smooth tongue), terrestrial insects, and a variety of crustaceans, including crab and barnacle larvae (166). Adults eat herring, sand lance, pilchard, and rockfish (166).

Chinook salmon grow to 58 inches (166) and are both important as commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - Being anadromous and utilizing larger rivers (166), would allow the chinook salmon to occur in any of the waters of this study. This is reflected in the catch record summary where "50 or more" reports occur in all 12 inside waters study areas (C). The geographic record of these catches (D) show reports from nearly all areas. Concentration of reports (filling large bays) are located at Everett Bay, Port Susan, Skagit Bay, North Bellingham Bay, Port Discovery, and Tacoma Narrows. Many other areas have lesser concentrations of chinook salmon reports. No comparable record of catches exists for the western Strait of Juan de Fuca and coast.

A North Sound beam trawl survey (I) did not capture chinook salmon as might be expected where young may be in untrawlable shallow waters and adults in midwater/surface pelagic waters. In an ongoing North Sound survey (H), chinook salmon were of common occurrence in all study habitats (as shown by tow net). Juvenile chinook salmon were taken in nearly all habitats from June through September and in the gravel habitat in March (H).

On the coast, the Columbia River is the most important chinook producing system (J). Few chinook salmon were taken in summer or winter sampling in Grays Harbor (G), however, sampling gear was more oriented to demersal species. This salmon's use of Grays Harbor was previously described.

The spring and fall chinook runs represent a very valuable salmon fishery in Grays Harbor (G).

In Willapa Bay, chinook salmon utilize the Bay and estuary as a feeding and nursery area as well as a migration route (July through October) to tributary streams for spawning (E). Emigration of young chinook salmon to or through the Bay occurs during May through July (E). Salmon juveniles can be found in the Bay throughout the year (E).

The Columbia River estuary (to Puget Island and including the Oregon side) receives the largest escapement of chinook salmon. Some fish are destined for Washington streams while others go to Oregon and Idaho. Numbers escaping to the Columbia system are not counted specifically for Washington home streams, nor counted in the area of interest (mouth to Puget Island).

The table that follows summarizes the ten top chinook rivers or river systems in Washington based upon WDF (R) and ACOE (S) data:

	River or Basin (1)	Natural and Artificial Escapement (1966-1971 Average) (2)
1.	Columbia River (includes Oregon) at Bonneville	391,000[1]
2.	Lower Chehalis	22,000
3.	Skagit-Samish	20,650
4.	Queets-Quinault	18,000
5.	Green	15,200
6.	Soleduck-Hoh	15,000
7.	Hood Canal	12,000
8.	Lake Washington-Cedar	10,500
9.	Snohomish	9,300
10.	Willapa	8,490

Note: These numbers are given only as indicators of abundance; run size varies from year to year in all these systems.

[1]Numbers larger in the lower Columbia River.

HABITAT REQUIREMENTS - This section excludes the freshwater cycle except to indicate that chinook salmon prefer larger rivers (166) with rather stable river conditions (322). Estuaries and the marine areas associated with larger rivers would be expected to have concentrations of outmigrating young and inmigrating adults. The marine and estuary life history of this salmon and others has been the subject of less research than the life history phases in fresh water.

The chinook salmon uses the open water habitat type but is bottom-associated in the shallow water-estuarine juvenile life stage (for 30 to 60 days, R) and as a returning adult. The remaining marine juvenile and adult life is as a pelagic (surface to midwater) fish.

All the open water habitats of this study are potentially used as transport areas for chinook salmon - either as young moving to sea or as adults returning from the sea.

From 1965 to present, the WDF has completed visual nearshore indeces of young salmon in the marine environment in nearshore areas. This study was to assess stocks and predict adult returns (particularly of pink and chum salmon). (Ray Johnson, WDF, Personal Communication.)

The following is a synopsis of juvenile chinook salmon habitat requirements in marine and estuarine waters (Ray Johnson, WDF, Personal Communication):

Juvenile chinook salmon are generally between sockeye and coho (larger fish) and pink and chum salmon (smaller fish) as they leave the river to enter the estuary and marine environment. As a moderately sized fish, chinook are presumed to utilize shore areas similar to pink and chum salmon (in daytime) but possibly be a little farther from shore and not right on the beach. This "shore-hugging" posture is thought to provide protection and food to juvenile chinook salmon. At night these chinook juveniles are more scattered and move into the open waters away from the shore. The general shore type favored appears to be a low sloped gravel/sand/mixed coarse type. They also occur next to steep sloped rocky shores where more pelagic organisms are eaten, as compared to the epibenthic foods eaten over the low sloped beaches. Mud flats even at the mouth of large rivers (Skagit Bay), while being important transport habitat, do not seem to have the requirements to hold feeding juveniles. While near shore, chinooks are distinguishable from pinks and chums by their reaction to perturbations - chinooks scatter, while pinks and chums school. Some areas in WDF indexing locations consistently have the largest numbers of young salmon. These areas are generally cove areas in straighter stretches of coastline and bays in areas of more exposed coastline (i.e., Discovery and Sequim Bays in the eastern Strait of Juan de Fuca). Generally, as the juvenile salmon grow larger, they move to deeper water and move out to sea.

The North Sound study (H) indicates little specific habitat choice by chinook salmon as all types were used.

CRITICAL HABITAT AREAS - Chinook salmon are potentially located in all waters of this study. Areas where the greatest numbers of adult chinook return to rivers is given in the table of the ten top Washington chinook salmon rivers. Presumably these same rivers would be the source of the greatest numbers of juveniles entering the estuarine and marine environment. The juvenile chinook salmon move along shore (going to deeper water with age) in the daylight hours and move towards the open ocean, generally traveling outside the State's waters to California and Alaska.

The problem with a critical area determination is that all areas (at certain times) may be critical, either in the transport of juveniles and adults or the feeding and protection of small juveniles. Cove and bay areas are mentioned as important for these juveniles.

Information available at WDF may be able to define certain areas (at least in the indexing locations) that fit the critical habitat area definition. However, neither this study group nor WDF can presently review all volumes of various survey data and other WDF information to establish where these areas are.

No specific critical areas were identified from the information reviewed. Some indicate all open waters are critical at certain times while others indicate all the feeding/nursery areas of young chinook along the shores of inside waters, the coast, coastal bays and the Columbia River estuary are critical for the chinook salmon there. More review of WDF and other studies would be necessary to separate out specific critical areas for chinook salmon.

DATA GAPS - Two basic activities should be completed for chinook salmon. One activity would be a catch summary for this species in the western Strait of Juan de Fuca and coast. The second, and much more difficult task, would be to complete an inventory of manuscripts, reports, catch records, and other general observations in hand by WDF for chinook salmon in the marine and the estuarine environment. The logical approach to this data compilation of existing material would be to contract WDF directly as their personnel would have the best understanding of the data in WDF files that would be useful for chinook salmon habitat characterization in the marine and estuarine waters of Washington. The early marine life history (feeding, nursery, and migration areas) needs to be studied for chinook salmon.

After this catch summary and existing data compilation is completed, one could better decide on data gaps existent for chinook salmon in Washington waters.

REFERENCES - C, D, E, G, H, I, J, K, R, S, 23, 166, 218, 539, 780.

FACT SHEET

F-69 COHO SALMON (SILVER)

Oncorhynchus kisutch

LIFE HISTORY - The coho salmon is the second largest Pacific salmon (in terms of size) and like the chinook salmon (F-68) is intensively cultured in Washington. A 1966-1971 average indicates coho salmon are cultured in numbers over three times that of chinook salmon (R). The comments in the first part of the chinook salmon (F-68) life history section are applicable to coho salmon.

The focus of this description will be on the less understood marine and estuarine life history as compared to the fresh water life history. Coho salmon spawn both in large rivers and their headwaters as well as small streams (166). The adult migration is chiefly in September and October but may extend into December (J) and in upper Grays Harbor to January (218).

Maturity is reached as early as two years (males, "jacks") but most coho salmon are three years old while a few may be four years old (J). Fecundity is 2,500 to almost 5,000 eggs/female, depending on size (166). Adults die after spawning (523). After spawning and hatching, the young usually remain in fresh water for a year (166). Young school up before moving out to sea (G). In general, coho salmon are in salt water from the Spring (about April ?) of their second year to November of the third year (96). Maturing fish return to home streams to repeat the cycle.

A brief tabular summary of coho life history (R) follows:

COHO SALMON (Oncorhynchus kisutch), also called silver, silverside, and hooknose.

	SMALL TRIBUTARY	LARGE TRIBUTARY	MAIN RIVER	ESTUARY	OCEAN	GENERAL COMMENTS
Mature Adults (spawning)	30 to 60 days late fall through early winter.		Some use especially in side channels			Adults always die after spawning.
Eggs & Larvae (incubation)	80 to 150 days winter months					Average number of eggs 3,000 per female.
Juveniles (rearing)	12 to 14 months, spends entire year in stream.		Some use, extent unknown	30-120 days seaward migration		Populations limited by low summer flow conditions.
Growth to Maturity					Spend 1 2 yrs at sea 2 yrs. typ.	Ranges north and south in ocean; some in Puget Snd. prop.
Maturing Adults	Returning to original spawning grounds to complete life cycle, normally at age 3 years.					Average weights 8-10 lbs. 31 lbs. maximum weight.

Migrations of coho salmon can be quite extensive (about 1,000 miles, 166). In general, coho salmon in Puget Sound are native to that area, while those in the Strait of Juan de Fuca originate in Puget Sound and Strait of Georgia basins (23). San Juan Islands coho salmon probably originate in Georgia Strait streams (23). Most juvenile coho migrate northward in inside waters, with a few migrating offshore (255). Puget Sound coho are also reported to migrate as far as the north end of the Vancouver Island and south to the Columbia River, but many never enter the open ocean (539).

Coho salmon migrations at sea cover less area than chinook salmon, but there is a considerable interchange between Washington and adjacent waters (J).

Foods of young coho salmon include herring larvae, sand lance, kelp greenling, rockfish, eulachon, insects, crustaceans and larvae of copepods, amphipods, barnacles and crab (166). Adults eat squid, euphausiids, fish, including lantern fish and sauries (166).

Coho salmon grow to 38.5 inches (166) and are both an important commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - With their use of small and large streams and the anadromous life cycle, all waters of this study are potentially used by coho salmon. This is one of the most numerous salmon in Washington waters (R) and comprises about 60 percent of the Northwest's salmon sport catch (K). In WDF data for 1966-1971 (R), coho are second to chum salmon (F-71) in spawning escapements to river basins of Washington, other than the Columbia.

This abundance is reflected in the catch record summary (C) with all areas having "50 or more" reports except Port Orchard. Port Orchard has a 50+ record in a following study (D). The geographical record of these catch reports (D) shows coho salmon in concentrated areas too numerous to mention - in both large and small bays and open water areas. No comparable catch summary exists for the western Strait of Juan de Fuca and coast.

The North Sound beam trawl survey (I) did not report this species as would be expected. In the ongoing North Sound Study (H), coho salmon (juveniles) were reported as common occurrences in all habitats except gravel, where it was uncommon, (as shown by tow net) and as a common occurrence in sand/eelgrass and cobble habitats and uncommon in the gravel habitat (as shown by beach seine). These juveniles were observed in most of these habitats in May through October with a gravel habitat catch in January (H).

On the coast, the Columbia is the largest coho salmon producer. In the Grays Harbor study a few yearling coho were taken in North and South Channels in February and March (G). Adult coho enter Grays Harbor from early September through January (G). Grays Harbor has larger numbers spawning of coho than Willapa Bay (R).

In Willapa Bay coho salmon utilize the Bay-estuary as a feeding and nursery area as well as a migration route to tributary streams (E). Coho (adults) migrate in Willapa Bay from July through November but are found during most months of the year (E). Emigration of young coho salmon to or through the Bay is from April through June (E).

The Columbia River estuary (to Puget Island and including the Oregon side) receives the largest escapement of coho salmon. Some fish are destined for Washington rivers while others go to Oregon and Idaho. Numbers escaping to the Columbia system are not counted specifically for all Washington home streams nor counted in the area of interest (mouth to Puget Island).

The tables that follow summarize the ten top coho salmon rivers or river systems in Washington, based upon WDF (R) and ACOE (S) data:

	River or Basin (1)	Natural and Artificial Escapement (1966-1971 Average) (2)
1.	Lower Chehalis	116,600
2.	Columbia River, includes Oregon (at Bonneville)	72,900[1]
3.	Kitsap	53,300
4.	Snohomish	52,500
5.	Queets-Quinault	45,000
6.	Green	43,500
7.	Skagit-Samish	38,700
8.	Lake Washington-Cedar	31,200
9.	Willapa	29,500
10.	Soleduck-Hoh	25,000

Note: These numbers are given only as indicators of abundance; Run sizes vary from year to year in all these systems.

[1]Numbers larger in lower Columbia River.

HABITAT REQUIREMENTS - This section excludes the freshwater cycle except to indicate that coho salmon utilize a wide variety of stream sizes, large rivers, and headwaters to small streams. Estuaries of many rivers of Washington would potentially be used by coho salmon unless stream characteristics prevent successful reproduction by coho salmon. The marine and estuarine life history of the coho salmon has been the subject of less research than the life history phases in fresh water.

The coho salmon uses the open water habitat type but is bottom-associated in the shallow water estuarine juvenile life stage (for 30 to 120 days, R) and as a returning adult. The remaining marine juvenile and adult life is as a pelagic (surface to midwater) fish.

All open water habitats in this study are potential transport areas of coho salmon. Numbers of coho salmon adults and juveniles entering marine and estuarine waters would be greatest in the vicinity of the streams previously described as having the largest runs in Washington in recent times.

The young coho salmon habitat, upon entering the estuary and marine environments, would be expected to differ from the smaller sized pink and chum, but be similar to the larger sized sockeye juveniles. With their larger size, cohos entering these waters would be expected to occupy somewhat deeper waters, being a little less shoreline oriented in daylight hours. This is assumed because of the larger size and the need for less protection and possibly different food types are utilized. The WDF marine salmon survey is oriented primarily to pink and chum salmon but does note juvenile of coho salmon (like sockeye salmon) in shallow waters with an increasing use of deeper waters with age. (Ray Johnson, WDF, personal communication).

These waters are not initially as shallow as those for pink, chum, and chinook salmon. As described for chinook salmon (F-68) juvenile coho probably also utilize indentations (coves) in straighter stretches of beach as well as bays in areas of exposed coast in inside and outside waters. Substrate types are probably similar to those described for chinook salmon (F-68), sand/gravel/mixed coarse, used more than mud flats. The North Sound tow net survey (H), found juvenile coho in common occurrence over all habitats, except gravel, where it was an uncommon occurrence. A wide range of habitats may be used if they provide the food and protection required by coho salmon.

CRITICAL HABITAT AREAS - The introduction to this section for chinook salmon (F-68) would also be applicable to coho salmon.

As with chinook salmon (F-68), all areas of this study might be considered critical at some time in the year when adults pass through an area or when juveniles move from river to shoreline areas and go out to sea beyond State waters.

Information gathered over the years by WDF may be able to define certain areas (at least in indexing and fishing locations) that fit the critical habitat area definition for coho salmon. However, neither this study group nor the WDF can presently review all the volumes of various survey data and other information to establish where these areas are.

No specific critical areas were identified from the information reviewed. Some people would indicate all open waters as transport areas are critical at certain times of the year, while others would point to all shallow water "nursery" areas that are used by juvenile coho salmon. These would include inside water coves and bays, and coastal bays, and the Columbia river estuary.

More review of existing WDF and other studies would be necessary to separate out specific critical areas for coho salmon.

DATA GAPS - See chinook salmon (F-68)

REFERENCES - C, D, E, G, H, I, J, K, R, S, 23, 96, 166, 218, 255, 523, 539.

FACT SHEET

F-70 PINK SALMON (HUMPY)

Oncorhynchus gorbuscha

LIFE HISTORY - The pink salmon is the most abundant salmon in Washington waters (excluding the Columbia River) based upon 1966-1971 WDF spawning escapements (R). Unlike chinook (F-68), coho (F-69), and chum salmon (F-72), the pink salmon is not cultured in Washington, at least in numbers reported by WDF (R). This life history section will focus on the less understood marine and estuarine life history as compared to the freshwater life history.

A unique life history characteristic of pink salmon is a consistent two-year life cycle to affect heavy runs in odd numbered years (913, 64, 255) while small runs occur in even numbered years (255). One source (K) indicates the southern spawning range is Washington State. Another source (166) reports California as the southern limit of their marine life history.

Pink salmon usually spawn in the lowest parts of rivers but sometimes go well upstream (166). Large cold rivers of Puget Sound are used (K). Spawning streams are entered in August and September (J), and later October (166). Adults are seen in Hood Canal in late July (780). Adults always die after spawning (R).

Pink salmon mature at two years of age (64, 166). Fecundity is reported as 1,500 to 2,000 eggs/female (64). The two-year life span perpetuates the large odd year runs in Washington.

After hatching (late February) and emerging from the gravel (April and May) in British Columbia, the young move right to the sea (166). Downstream moving fry, in large schools, in shallow waters are observed in the Hood Canal streams in late Spring (780). In general, fry move immediately to saltwater (April-May) and remain inshore through July. Pink salmon are in saltwater from this April to May period to the following year's August to October period when they have matured and return to home streams to repeat the cycle.

A brief tabular summary of pink salmon life history (R) follows:

PINK SALMON (Oncorhynchus gorbushcha), also called humpback salmon or humpy.

	SMALL TRIBUTARY	LARGE TRIBUTARY	MAIN RIVER	ESTUARY	OCEAN	GENERAL COMMENTS
Mature Adults (spawning)	Some use	30 to 60 days early fall months on odd yrs. only.				Adults always die after spawning.
Eggs & Larvae (incubation)	Some use	90 to 150 days winter months.				1,500 to 2,000 eggs per female.
Juveniles (rearing)		Move to sea soon after hatching.		Spends approx. 3-4 months in shoreline areas.		Little if any fresh-water growth.
Growth to Maturity					Spend approx. 12 mo. at sea	Ranges generally north: mature at 2 years.
Maturing Adults		Returning to original spawning grounds to complete life cycle, always at age 2 years.				Average weights 5-6 lbs. 16 lbs. maximum.

Migrations of pink salmon from British Columbia and Washington are fairly extensive, some 500 nautical miles from land and from the Gulf of Alaska off Prince William Sound to about Monterey Bay in California (166). Pink salmon in Puget Sound are native, originating in Strait of Georgia and Puget Sound basins (23). A general migration pattern is north in Summer and south in Winter (21). Puget Sound juveniles may move into the San Juan archipelago or they may migrate (255). Heavy migrations are reported through the Straits of Juan de Fuca in odd years (913). In early life history stages (juvenile), these Straits are inhabited before going offshore to feed (535).

Food of pink salmon young includes copepods, *Oikopleura*, chaetognathes, amphipods, euphausiids, and young fish (herring, eulachon, smoothtongue, hake, pricklebacks, gobies), while adults eat euphausiids, copepods, amphipods, fish and squid (166). Food of adults in descending order of importance in one survey (255) was: Euphausiids, decapods, fish, mysids, molluscs, copepods, and amphipods. One source (28) indicated epibenthic organisms and not zooplankton were the important food types of pink salmon feeding in very near shore and intertidal areas in Puget Sound. This source (28) is probably the most relevant to pink salmon of Washington and should be reviewed for additiional details.

Pink salmon grow to 30 inches (166) and are both important as commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - The anadromous life cycle and feeding migrations of pink salmon could place pink salmon in most of the waters of this study area. The Stillaguamish, Skagit, Snohomish, Puyallup, and Nooksack watersheds are Washington's main pink salmon producers (J). Inside water basins (including the Strait of Juan de Fuca) have 650,000 pink salmon escapement while coastal streams have a 1,000 pink salmon escapement (1966-1971 average) (R).

The catch report summary (C) indicates "50 or more" reports in all but one subdivision - Port Orchard, which has no reports. The geographical distribution of these catches in inside waters (D) show concentrated reports in marine areas near the above mentioned main pink salmon rivers of Washington as well as Discovery Bay, Dungeness Bay, and the south end of Whidbey Island. No comparable records exist for the western Strait of Juan de Fuca and coast.

The North Sound beam trawl survey (I) did not report the pink samon as might be expected. In an ongoing North Sound study, juvenile pink salmon were an uncommon occurrence in all habitats (as shown by tow net) and uncommon in gravel and cobble habitats (as shown by beach seine) (H). Pink salmon juveniles were located in these habitats in June and July except for some caught in the gravel habitat in February (H).

Pink salmon were not taken in the Grays Harbor Study (G) or reported there by other sources (218, R). Pink salmon are also not reported for Willapa Bay (E, F).

The Columbia River (mouth to Puget Island) is not assessed for total escapement of this or other salmon species. Some of the fish would be on the Oregon side of this area. Few pink salmon ascend the river as far as Bonneville Dam (S). The tables that follow summarize the eight top pink salmon rivers or river systems in Washington based upon WDF (F) and ACOE (S) data:

River or Basin (1)	Natural Escapement (1966-1971 Average) (2)
1. Skagit-Samish	166,000
2. Hood Canal	140,000
3. Stillaquamish	125,000
4. Snohomish	96,000
5. Elwha-Dungeness	65,000
6. Puyallup	26,000
7. Nooksack	25,000
8. Nisqually	7,000

Note: These numbers are given only as indicators of abundance; Run sizes vary from year to year in all these systems.

HABITAT REQUIREMENTS - This section excludes the freshwater cycle except to note that pink salmon do utilize several main rivers in Washington and would be expected to be more numerous in the estuaries and adjacent waters when juveniles are coming into the marine/estuarine areas, and when adults return to these streams to spawn. Again, as for other salmon, the marine/estuarine life history has been less studied than the freshwater part of the cycle.

The pink salmon utilizes the open water habitat type but is bottom-oriented in the shallow water estuarine juvenile life stage (for three to four months in these shoreline areas, R) and as a returning adult. The remaining marine juvenile and adult life is as a pelagic (surface to mid-water).

All of the open water habitats of this study are potentially used as transport areas for pink salmon. Pink salmon juveniles spend the longest period of time (three to four months) in the nearshore shallow waters (daylight hours) right on the beach. Pink salmon are assumed similar to chum salmon (F-72) having highest mortalities in this juvenile coastal period. From 1965 to present, WDF has completed a visual index of young salmon in these nearshore areas, focusing on this species and chum salmon (F-72). This study is oriented to assessing stocks and predicting adult returns (Ray Johnson, WDF, personal communication). The WDF description of these pink salmon areas is as follows (Ray Johnson, WDF, personal communication): Juvenile pink salmon hug the shore in daylight hours right next to the beach in intertidal areas when the tide is in. This region is thought to provide protection and food for these small salmon. At night, pink salmon fry move out into the deeper waters apparently to operate in more exposed waters under cover of darkness. The general shore type favored appears to be a low sloped gravel/sand/mixed coarse type. They also occur next to steep sloped rocky shores where more pelagic organisms are eaten as compared to the epibenthic foods eaten over the low sloped beaches. Mud flats, even at the mouths of large rivers (Skagit Bay), while being important transport habitat for juvenile and adults, do not seem to have the requirements to hold large numbers of feeding juveniles. While near shore, pink and chum salmon (F-72) juveniles are distinguishable from chinook fry by their reactions to perturbations - pinks and chums school, while chinook juveniles scatter. Some areas in WDF indexing locations consistently have the largest numbers of young salmon. These are generally cove areas in straighter stretches of coastline and bays (i.e., Discovery and Sequim Bays in the eastern Strait of Juan de Fuca). Generally, as these juvenile salmon grow larger, they move to deeper waters and out to sea.

CRITICAL HABITAT AREAS - Pink salmon are potentially located in all waters of this study. Areas with the greatest numbers of juvenile and adult pink salmon would be those marine and estuarine areas adjacent to the ten major rivers for this salmon species in Washington (previously listed).

The critical life stage in the marine and estuarine life history appears to be this entrance period into this area and the three to four months spent in very shallow nearshore waters before moving to deeper water and going to sea. This is the time of highest mortalities in a similar salmon species - chum salmon (F-72).

The problem in a critical area determination for pink salmon is that all areas (at certain times) may be critical either in the transport of juveniles or adults or the feeding and protection of small juveniles. Cove and bay areas are mentioned as important for these juveniles.

No specific critical areas in Washington were determined from the information reviewed. Some would indicate all areas of transport or nursery use should be called critical. However, some of these areas must be more important than others and this could not be determined from the information reviewed. More review of WDF and other study data would be necessary to separate critical areas for pink salmon.

DATA GAPS - See chinook salmon (F-68).

REFERENCES - C, D, E, F, G, H, I, J, K, R, S, 21, 23, 28, 64, 166, 218, 255, 535, 780, 913.

FACT SHEET

F-71 SOCKEYE SALMON (RED)

Oncorhynchus nerka

LIFE HISTORY - The sockeye salmon, while abundant in a few rivers, has the second lowest escapement (above chinook salmon, F-68) in Washington, excluding the Columbia River (WDF, 1966-1971, R). In the WDF data (R), two basin systems, Lake Washington-Cedar and Queets-Quinault have over 93 percent of the total escapement for Washington rivers excluding the Columbia River. This section will focus in the marine and estuarine part of this anadromous salmon's life history.

The sockeye salmon is similar to the coho salmon in usually remaining one year in fresh water before going to sea, but is unique to all the salmon species by (usually) having a lake (or lakes) required in the river system used for spawning (322). In Washington these include three main systems, the Columbia River and the two above mentioned basins.

Spawning streams are entered in Summer (166), June through August (64). Most sockeye spawn after making long migrations upstream to and through inland lakes while some spawn quite close to the sea (166).

Sockeye mature in three to four years (64) and fecundity is reported as 2,000 to 2,500 eggs/female (64), (2,000 to 4,300 eggs/female, 166). Adults die after spawning.

Most young sockeye salmon remain about one year in fresh water before going to sea, but some go immediately to sea while others remain two years or longer (particularly in the northern part of the range in Alaska) (166). Some never go to sea (166). Lakes in the river system are nursery areas for the young.

Young sockeye reach the ocean in the early Summer and remain for a short time in inshore or even in the influence of the home river (166). Another source (8) indicates the one year old sockeye move from the Fraser River to salt water in May through July. River flow rates and water temperatures determine the timing of this movement to the sea. The juveniles feed and move seaward, returning with maturity to repeat the cycle.

A brief tabular summary of sockeye salmon life history (R) follows:

SOCKEYE SALMON (*Oncorhynchus nerka*), also called red salmon, blueback, kokanee or silver trout.

	LAKE TRIBUTARY	LAKE SYSTEM	MAIN RIVER	ESTUARY	OCEAN	GENERAL COMMENTS
Mature Adults (spawning)	2-4 months late summer & fall	Some shoreline spawning	Main migration June, July, Aug.			Adults always die after spawning.
Eggs & Larvae (incubation)	90 to 150 days winter months.					Spawns 2,000 -2,500 eggs per female.
Juveniles (rearing)		1 to 3 yrs. spent in lake	These areas used during seaward migration.			Some stay to maturity in lake (kokanee) to 2 lbs. weight.
Growth to Maturity					2-3 yrs. variable.	Ranges generally north to Alaskan waters.
Maturing Adults	Returning to original spawning grounds to complete life cycle, normally at age 3 or 4 years.					Average weights 5 - 7 lbs. 3-4 lbs. in Columbia River.

Migrations of sockeye salmon are quite extensive with Washington and British Columbia fish going as far west as about 175° W (and south of the Aleutian chain) (166). The fish remain inshore for the early part of the Summer, and then move to the open ocean (166). They then scatter into the northeast Pacific mainly near the surface (166). The migrating population tends to move south in the Winter and north in the Summer. During the Summer older fish (two to three year ocean fish) begin to mature and move shoreward to complete the cycle. The southern limit of commercial quantities of sockeye salmon is at the mouth of the Columbia River (166).

The inside water migration of adult sockeye to the Fraser River is in May to October. It is described from the south end of San Juan Island and Lopez Island to Rosario Strait past Lummi Island and Birch Bay to Point Roberts and on to the Fraser River mouth (8).

Food of young sockeye salmon include crustaceans (such as copepods, amphipods, decapods, etc.), young fish and their larvae (sand lance, bigeye whiting, starry flounder, herring, rockfish, etc.) (166). Adult sockeye salmon eat euphausiids, amphipods, copepods, squid and young fish (166).

Sockeye salmon grow to 33 inches (166) and are both important as commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - The anadromous life cycle and feeding migrations could place sockeye salmon in most of the waters in this study. Unlike the other salmon, however, three systems account for nearly all of the sockeye homing to Washington streams - Lake Washington-Cedar River, Queets-Quinault, and the Columbia (R, S). Fraser River fish do pass through Washington waters. Therefore, a less scattered distribution in inside waters would be expected as compared to these other salmon. On the coast, the Columbia River is the southern limit of commercial quantities of this species (166).

Sockeye salmon are reported in "50 or more" reports in nine of the twelve inside water areas of Washington (C). No reports exist for the Port Orchard and Colvos Passage areas, while "10 to 49" reports exist for South Puget Sound (C). In the geographical summary of sockeye reports (D), sockeye salmon reports are concentrated in approach areas from the Strait of Juan de Fuca to the Seattle vicinity (Admiralty Inlet) and to the Fraser system (?) in Rosario Strait. Other report concentrations are in Skagit and Bellingham Bay (D). No (or few) reports are indicated for Hood Canal and the Sound south of Seattle (D). No comparable catch report summary exists for the western Strait of Juan de Fuca and coast.

The North Sound beam trawl (I) survey did not catch sockeye salmon as might be expected. In an ongoing North Sound study (H), sockeye salmon (juveniles) were found an uncommon occurrence in the mud/eelgrass and gravel habitats (as shown by tow net). Juveniles were taken in these habitats only in June, indicating a much shorter residence time compared to other salmon species, including coho salmon (F-69) which have a comparably aged fish entering the marine invironment.

In the Grays Harbor study (G), sockeye salmon were not taken. In Willapa Bay they were not reported (E, F). They would not be expected in these bays except as strays, possibly from the Columbia River or Queets-Quinault system.

The Columbia River estuary would be the transport area for one of the larger runs of sockeye into Washington. Unfortunately, runs are not assessed in the lower part of the Columbia River (below Puget Island). Some of the fish would be on the Oregon side of this area. The table that follows summarizes the five top sockeye rivers or river systems in Washington based upon WDF (F) and ACOE (S) data:

	River or Basin (1)	Artificial Escapement (1966-1971 Average) (2)
1.	Lake Washington-Cedar	148,000
2.	Columbia River - includes Oregon (at Bonneville)	104,500[1]
3.	Queets-Quinault	100,000
4.	Soleduck-Hoh	15,000
5.	Skagit-Samish	2,100

Note: These numbers are given only as indicators of abundance; Run sizes vary from year to year in all these systems.

[1]Numbers larger in lower Columbia River.

HABITAT REQUIREMENTS - The sockeye salmon uses the open water habitat type, being briefly bottom-associated as juveniles when entering the marine and estuarine environments and as adults when returning to streams to spawn.

Most open water habitats in this study are potentially used as transport areas for sockeye salmon with the possible exception of parts of South Sound and Hood Canal, where sockeye are not reported or are not very abundant. Transport routes of importance would be through the Columbia River Estuary, though the nearshore waters off the Quinault River mouth and in the Admiralty Inlet, Rosario Strait, and Georgia and Juan de Fuca Straits.

Young sockeye salmon apparently do not spend as much time near shore as coho and other salmon species. The North Sound study captured sockeye juveniles in only one month - June, indicating a brief residence time in the nearshore waters sampled in this study (H). While briefly in shallow waters (nearshore) they would be expected to use habitats similar to those described for chinook salmon (F-68). In the open water habitat they would be in the surface or near surface waters.

CRITICAL HABITAT AREAS - Sockeye salmon can potentially occupy most open habitat areas of this study. Unlike the other salmon species, sockeye salmon are restricted to a few river systems and these, as listed earlier, would presumably have adjacent marine and estuarine areas with the greatest numbers of adult sockeye as well as juvenile sockeye. Major transport areas were noted in the previous section. Sockeye salmon do not have the extended nearshore stay seen in other salmon species, making this early marine life stage apparently less critical than for these other species.

Specific critical areas for sockeye salmon in Washington were not located in the information reviewed. It is probable that a more extensive review of WDF and other studies would provide the necessary input to locating specific critical areas for sockeye salmon.

DATA GAPS - See chinook salmon (F-68).

REFERENCES - C, D, E, F, G, H, I, R, S, 8, 64, 166, 322.

FACT SHEET

F-72 CHUM SALMON (DOG)

Oncorhynchus keta

LIFE HISTORY - The chum salmon is third in order of abundance in Washington (1966-1971 averages, R, S), behind coho and pink salmon in rivers excluding the Columbia. The Columbia River has few chum salmon reaching up to the first counting area - Bonneville Dam (S). The comments in the first part of this section for chinook salmon (F-68) apply to chum salmon. Chum salmon mature after two to seven years (usually three to five) (mostly in fourth year, 15) at sea (166). The fecundity is reported as 3,000 to 3,500 eggs/female (64), (2,000 to 4,300, 166) (900 to 8,000, 15). Generally, chum salmon approach shore in autumn (October to December, J), home to natal streams and spawn late in the year, (the latest of the Pacific salmon, 166). They utilize a variety of stream sizes and spawn frequently near the sea but also well up some large rivers (166). They are reported to spawn within 200 km of the sea (15).

Fry are hatching in the Spring (J), move immediately to sea (28, K, J, 322). The juveniles frequent shallow shoreline areas (28) moving to deeper waters with age. Chum salmon migrate to sea and return, apparently moving quickly through our coastal waters (K) to their natal stream to repeat the cycle. Juveniles are in upper Grays Harbor from February to at least mid-June, peaking in late March and April (218).

A brief tabular summary of chum salmon life history (R) follows:

CHUM SALMON (Oncorhynchus keta), also called dog salmon or fall salmon.

	SMALL TRIBUTARY	LARGE TRIBUTARY	MAIN RIVER	ESTUARY	OCEAN	GENERAL COMMENTS
Mature Adults (spawning)	Some use	Up to 30 days. Late fall early winter months.				Adults always die after spawning.
Eggs & Larvae (incubation)	Some use	90 to 150 days winter months.				Spawns 3,000 to 3,500 eggs per female.
Juveniles (rearing)		Move to sea soon after hatching.		Spends approx. 3-4 months in shoreline areas.		Little if any fresh-water growth.
Growth to Maturity					3-5 yrs. at sea variable.	Range north to Alaskan waters.
Maturing Adults		Returning to original spawning grounds to complete life cycle, normally at age 3 or 4 years.				Average weights 11-12 lbs. 25 lbs. maximum.

Migrations of chum salmon from British Columbia, Washington, and Oregon are extensive going into the North Pacific to the Aleutians and as far west as about 168° W longitude (166). Chum salmon are reported to the Sacramento River (166) but Washington fish at sea apparently move northward off British Columbia and go into the North Pacific Ocean (166, 255).

After juveniles enter saltwater in early spring, they remain inshore during the summer, and begin moving offshore in September (166). In August and September juveniles move north within 32 km of the Washington shore (15). General migrations are north in summer and south in winter (21). Spawning migrations are described in the fall (Hood Canal, British Columbia), October to December (Washington), mid-October to mid-November (Grays Harbor) (166, 780, 218). Apparently adults move quickly through State waters on their spawning migration from the North Pacific (K).

Foods of chum salmon (young), upon entering seawater, includes insects (on occasion), copepods and *Oikopleura*, while adults eat euphausiids, squid, amphipods and crab larvae (166). A Puget Sound study of juvenile chum salmon diet of fish from the shallow nearshore to intertidal area was found to include epibenthic organisms rather than zooplankton as the main food (28). This source (28) should be consulted for more specific details on the variability and types of foods consumed by chum salmon.

Chum salmon grow to 40 inches (166) and are both important as commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - Chum salmon utilize many different inside and coastal Washington streams. They are fairly abundant in many of these streams (R) and therefore could be expected in most all of the waters of this study.

In the catch report summary for inside waters (C), chum salmon had "50 or more" reports in all twelve subdivisions, except one - Port Orchard, where none were reported. In a supplemental record summary (D), "50 or more" reports were located for Port Orchard. The geographic record of these reports in inside waters (D) show pink salmon report concentrations all over these waters but mainly in bays and narrow passages (Bellingham Bay, Skagit Bay, Port Susan, Discovery Bay, and Tacoma Narrows, to name a few). No comparable summary of chum catch records exists for the western Strait of Juan de Fuca and coast.

The North Sound beam trawl survey (I) did not report this species, as would be expected. The ongoing North Sound study, chum salmon (juveniles) were reported in common occurrence in all habitats (as shown by tow net), in uncommon occurrence in gravel (as shown by beach seine) and in uncommon occurrence (but abundant when encountered) in the gravel and cobble habitats (H). These juvenile chum salmon were seen in most of these habitats in May through September with the peak abuandance noted in the gravel habitat in May-June, and in the sand/eelgrass habitat in May (H), probably when chum salmon exited freshwater.

The numbers of chum salmon in the Columbia River system appear small because few fish reach the first counting area - Bonneville Dam, but are taken commercially in the lower river.

In the Grays Harbor study (G), no adult chum salmon were taken. Juvenile chum salmon were taken in late February and March in North Channel, South Channel and at Whitcomb Flats (G). In summer sampling, juvenile chum salmon were taken at all beach seine locations (two areas in North Channel, one in South Channel and three areas on Whitcomb Flats, G). Chum salmon are an important commercial species in Grays Harbor (G).

Chum salmon utilize Willapa Bay-Estuary as a feeding and nursery area as well as a migration route to and from tributary streams (E). Adult chum salmon pass through the Bay in October through November. While young chum salmon emigrate to or through the Bay in January through May (E). Juveniles can be found in the Bay throughout the year (E).

The Columbia River estuary (to Puget Island and including the Oregon side) is not counted for any salmon species. Fish in this area could be destined for Oregon as well as Washington streams. Counts at the first counting area - Bonneville Dam, are very low - second only to pink salmon (S). Chum salmon are reported taken commercially in the Columbia River (and coastal harbors) by gill net (J), so they must be present in some abundance in this lower Columbia River study area.

The list that follows contains the ten top Washington chum salmon streams based on WDF (R) and ACOE (S):

	River or Basin (1)	Natural and Artificial Escapement (1966-1971 Average) (2)
1.	Kitsap	76,400
2.	Skagit-Samish	52,700
3.	Willapa	31,263
4.	Hood Canal	30,500
5.	Nooksack	21,000
6.	Nisqually	16,500
7.	Shelton	16,300
8.	Lower Chehalis	16,000
9.	Puyallup	12,600
10.	Snohomish	12,300

Note: These numbers are given only as indications of abundance; Run sizes vary from year to year in all these systems.

HABITAT REQUIREMENTS - This section focuses on the marine and estuarine water habitats of chum salmon. The distribution of chum salmon rivers would indicate that chum salmon could (at certain times) be in most of the inside waters and outside bays and coastal areas of Washington.

The chum salmon utilize the open water habitat type but is bottom-associated in the shallow estuarine juvenile life stage (for about three to four months, R) and briefly as a returning adult. The remaining marine juvenile and adult life is as a pelagic (surface to midwater) fish.

All open water habitats in this study are potential transport areas of chum salmon. Numbers of chum salmon adults, and juveniles entering marine and estuarine waters, would be greatest in the above mentioned river systems.

A critical life stage in chum salmon is during the juvenile coastal period when mortality is highest (15). The description of these early marine and estuarine habitat requirements already described for pink salmon (F-70) is applicable to chum salmon.

CRITICAL HABITAT AREAS - No specific critical areas could be determined from the information reviewed. See pink salmon (F-70) for a detailed discussion of the critical habitat concept applied to a similar salmon.

DATA GAPS - See chinook salmon (F-68).

REFERENCES - C, D, E, G, H, I, J, K, R, S, 15, 21, 28, 64, 166, 218, 255, 322, 780.

FACT SHEET

F-73 MASU SALMON (CHERRY)

Oncorhynchus masu

LIFE HISTORY - The literature survey (A) has no information stored and one source (166) does not have this species. This anadromous species is located in the western Pacific. The masu salmon grows to a weight of 20 pounds (R) and is presently not in sufficient numbers to be of any commercial or sport importance in Washington.

WASHINGTON DISTRIBUTION - The masu or cherry salmon was apparently misidentified by one source (947) as located in North Sound and the San Juan Archipelago in a 1935 survey. The misidentification was noted by Bruce Miller, University of Washington (personal communication) and this species is not included in the "Checklist of Puget Sound Fishes" (C). Another source (R) indicates that the masu salmon closely resembles the coho salmon (F-69) but is smaller. This may explain the 1935 "observation".

A few experimental plants of masu salmon have been made in Washington State (R). Minter Creek and the Puyallup River were plant sites, having access to the marine and estuarine waters of Washington (Al Lassater, WDF, personal communication).

HABITAT REQUIREMENTS - No information was located.

CRITICAL HABITAT AREAS - The few introductions of masu salmon into Washington waters have been recent enough and of small enough magnitude to not have defineable marine and estuarine habitats, much less critical areas. If numbers of these salmon are as small as expected, a question would exist on the significance of these salmon in Washington waters.

DATA GAPS - No specific research on the marine/estuarine habitats of this species seems justified at present.

REFERENCES - A, C, R, 166, 947.

FACT SHEET

F-74 RAINBOW TROUT (STEELHEAD)

Salmo gairdneri

LIFE HISTORY - This section will deal with the marine and estuarine life of sea run rainbow trout (anadromous), which are commonly named steelhead trout. The sea run habit is accompanied by morphological differences and is hereditary (166). Winter and summer (adult) running tendencies for steelhead also appear to be inherited (166). This species, like chinook (F-68), and coho salmon (F-69), is intensively cultured in Washington.

Steelhead first mature usually at four years of age (64) but a range of two to six years is given for the Chehalis River (218) and two to eight years for British Columbia (166). Hatchery fish return predominantly as three year olds (K). Fecundity is reported as 3,500 to 4,000 eggs/female (64) depending on size and stock. Adults do not die after spawning (winter-spring, 780) and may spawn a second or third time (166). Juveniles spend two to three years in fresh water (range one to four years) (166). Chehalis River downstream migrants were one to three years old (218).

Time of spawning varies by river system and stock of steelhead. Most Washington rivers have steelhead migrating to spawn in the winter months (November to April). Fewer number (65,000 versus 135,000 in the 1973 cycle, T) of summer run steelhead occur in Washington with the bulk of these in the Columbia River system. These summer fish are in rivers in various months throughout the year although peaks in larger runs are in June to August.

Juveniles enter the marine environment from the Chehalis River from around February to July (218). Steelhead juveniles may enter marine and estuarine waters of Washington in all parts of the year. Definition of the timing of spawning or juvenile migrations is complicated by wild summer and winter run fish and hatchery fish (both summer and winter) in the same river systems. For the Grays Harbor/Chehalis River system, steelhead pass through the Harbor from November to April (peak late November through early March) and downstream from February through July (G). Young steelhead move through the Harbor mostly between March and June (G).

Migrations of steelhead after the 30 to 60 day estuary (and near-shore marine) stay may be quite extensive (166) going well beyond State waters. Washington, Oregon and California fish are reported in the Gulf of Alaska and North Pacific as far west as about 175° W longitude (166). Steelhead apparently spend most of their marine lives well offshore in the North Pacific (K).

Food of young steelhead consists of insects, euphausiids, copepods, amphipods, and other crustaceans, *Sagitta* and young fish (sand lance, eulachon, red devil, searcher, herring, and smooth tongue (166). High sea foods of steelhead include mainly fishes (young greenlings and a paralipid), and various crustaceans, indicating feeding had been near the surface (166).

The steelhead grows to 45 inches (166) and is an important sport fish in Washington.

WASHINGTON DISTRIBUTION - Steelhead trout utilize most rivers of Washington that have access to and from the sea so that this trout can be expected (at certain times) to be in most areas encompassed by this study. This is not borne out by the report summary for "rainbow trout" (steelhead) in inside Washington waters (C), which indicated only one area - Admiralty Inlet with "50 or more" reports of this species. The Bellingham and Everett areas have "10 to 49" reports, while the Georgia Strait, San Juan Islands, Port Orchard and Colvos Passage areas have no reports (C). The remaining five areas have "fewer than 10" reports (C). In the geographic summary of these inside reports (D) steelhead are primarily reported from the marine and estuarine areas near streams, the main exceptions being concentrations in the Bush Point area of Admiralty Inlet. Comparable summary records for the western Strait of Juan de Fuca and coast do not exist.

In the North Sound beam trawl survey (I), steelhead were not reported as might be expected. In our ongoing North Sound study (H), no steelhead were taken. In an ongoing Strait of Juan de Fuca study, a few steelhead were taken in August on an exposed gravel habitat (U, Charles Simenstad, University of Washington, personal communication).

In Grays Harbor, steelhead trout were not "reliably reported" during their sampling - a winter-sampled "salmonid sp." may have been a steelhead (G). Steelhead pass through the Harbor from November to April (peak late November through early March) (G). The spawned out adults move back downstream from February through July, while most young steelhead (mostly two year olds) move through the Harbor between March and June (G).

In Willapa Bay, steelhead use the Bay and estuary as a feeding and nursing area (E). Adult migrations are November through March, while young pass to or through the Bay in April through June (E). Young steelhead are found throughout the year in Willapa Bay (E).

The lower Columbia River area in this study receives the largest number of steelhead, bound for Washington, Oregon, and Idaho streams. No steelhead counts are made for this study area (upstream to Puget Island). The nearest main stream, Columbia River at Bonneville Dam, where the 1966-1971 average escapement was 136,786 steelhead (S). The lower Columbia River Washington streams (Cowlitz, Toutle, Lewis, and Kalama), as well as the lower Columbia River itself, are the high ranking areas of sport-caught winter run steelhead (T). The top ten summer run streams (1973) are all Columbia River or tributary streams.

The following table summarizes the catch records of the ten top winter (1973-1974) and summer (1973) steelhead streams in Washington (T):

Winter Steelhead:

	River (1)	Catch (2)
1.	Cowlitz River	19,421
2.	Green River (King County)	10,480
3.	Skagit River	10,223
4.	Skykomish River (All Forks)	7,162
5.	Snohomish River	4,634
6.	Snoqualmie River	4,598
7.	Toutle River (All Forks)	4,449
8.	Lewis River (All Forks)	4,013
9.	North Fork Stillaguamish River	3,838
10.	Puyallup River	3,757

Summer Steelhead:[1]

	River (1)	Catch (2)
1.	Lower Columbia River	6,633
2.	Upper Columbia River	6,052
3.	Snake River	6,033
4.	Toutle River (All Forks)	5,803
5.	Cowlitz River	5,249
6.	Kalama River	3,764
7.	Lewis River (East Fork)	3,200
8.	Lewis River (North Fork)	2,718
9.	Klickitat River	2,150
10.	Washougal River	2,103

Note: These numbers are given only as indicators of abundance; Run sizes vary from year to year in all these systems.

[1]All of these summer steelhead would pass through the lower Columbia River study area.

<u>HABITAT REQUIREMENTS</u> - No information was located on the marine and estuarine habitat requirements of steelhead. The literature search (A), and conversations with James Johnston (WDG, personal communication) located no information for steelhead. Steelhead would be assumed as juveniles in numbers in estuaries related to the catch report for the associated stream. After an initial period in the "home" estuary, these juveniles could move to other estuaries. The steelhead's early life in the marine environment is thought similar to that of cutthroat trout (F-45). See F-45 for further details.

The steelhead would use the open water habitat type, being somewhat bottom-associated as a juvenile and briefly while passing into the home stream as an adult.

As the fish grows older in the marine environment, however, the cutthroat pattern would appear to be lost, as steelhead do make extensive migrations into the high seas, rivaling the migrations of some of the salmon species. Steelhead apparently spend most of their marine lives well offshore (K). The larger fish taken in marine and estuarine areas are bound for their spawning streams. Steelhead in the Strait of Juan de Fuca were over an exposed gravel bottom (C. A. Simenstad, U. of Washington, personal communication).

CRITICAL HABITAT AREAS - Too little is known about the steelhead's marine and estuarine general habitat areas to say specifically where any areas are critical. Some would argue that all areas are potential transport areas for this widely distributed fish species, and at times are critical. Marine and estuarine concentrations and timing of distribution would have to be known before critical feeding and nursery areas could be defined. Rather than name all critical areas, this study will name no areas critical with a requirement for a great deal more information.

DATA GAPS - See cutthroat trout (F-45).

REFERENCES - A, C, D, E, G, H, I, K, S, T, U, 64, 166, 218, 780.

FACT SHEET

F-75 SURF SMELT

Hypomesus pretiosus

LIFE HISTORY - Surf smelt is a misnomer for this species, as this smelt occurs in non-surf areas in inside Washington waters in great numbers. Life span is three years (211, 166) (2 to 3 years, 490). Fecundity ranges from 2,500 to 37,000 eggs/female (444). Another range is 1,320 to 29,950 eggs/female depending on size and population (166). The species is sexually dimorphic at spawning time (444). Numerous local races exist in Puget Sound (920) all having unique ages of maturity and spawning times. The following decribes three smelt groups and the differences in maturity times (396).

Location	Age of Spawning	
	Males	Females
Hood Canal	90 percent at 1 year	90 percent at 1 year
Utsaladdy	43 percent at 1 year	88 percent at 2 years
La Push	95 percent at 2 years	78 percent at 2 years

Spawning occurs in most months of the year with eggs produced in batches over several days with repeat spawning although this is questioned (166). Spawning periods are listed as May until October (780) but is also given as June - September (open coast - 218). The Hood Canal spawning peak is between October and November (533). Spawning occurs on specific gravel beaches (K). See Habitat Requirements. Surf smelt apparently do not die after spawning unlike the longfin smelt (F-76) (J).

The smelt move on to these beaches in the evening or early morning at the water's edge at high tide (287). Eggs are buried six to ten cm (490). The eggs are adhesive (J). The young hatch in summer in 10 or 11 days (166) but in fall and winter hatching takes much longer (22 days, November, 287). The larvae are at the surface for four to six days after hatching (490). Subsequent life history is not known (166). They would presumably develop into pelagic life style of the adult with schooling and segregation by sexes. Sex ratios in samples are erratic with males predominant (166). With maturity the adults would return to specific beaches and repeat the cycle.

Migrations were not discussed in detail in the information reviewed. They do move offshore in the Strait of Georgia in April and June and are noted off the Washington coast (166). The small size and poor condition of Hood Canal fish (207) may mean these fish from inside waters stay in these waters and do not go to the open sea. Two inside groups are reported to not migrate through the Strait of Juan de Fuca (396). Coastal races of surf smelt may be the fish seen off the Washington coast.

Food includes a wide variety of crustacea, copepods, amphipods, crabs, larvae, euphausiids, shrimp larvae, marine worms, and such larval fish as eulachon, walleye pollock and prickle back (166).

This smelt grows to 8.75 inches (166) and is both important as commercial and sport fish in Washington.

WASHINGTON DISTRIBUTION - The surf smelt are widely distributed in Washington waters, with half the spawning areas of Puget Sound in South Sound (725) in Henderson, Budd, Eld, and Totten Inlets (975). The inside waters report summary indicates "50 or more" reports in seven of twelve areas and no reports in Georgia Strait and Colvos Passage (C). San Juan Islands and Central Puget Sound areas have "10 to 49" reports while the eastern Strait of Juan de Fuca has "fewer than 10" reports (C). The geographical summary of these inside water reports (D), are primarily in bays and near shore from Seattle and south, southern Hood Canal, Skagit and Bellingham Bays. Reports are also shown for the Georgia Strait area (north shore of Birch Bay) (D). No comparable summaries exist for the western Strait of Juan de Fuca and coast.

Surf smelt were not reported from a recent North Sound beam trawl survey (I). In an ongoing North Sound survey (H), surf smelt were reported as a common occurrence in all habitats (as shown by tow net) excepting the gravel habitat (uncommon occurrence). A similar pattern was shown by beach seine (H). Surf smelt (adults) were seen in these habitats in most months with the exception of April (H). Periods of peak abundance in the sand/eelgrass habitat was generally from August through February (H). Peaks in the mud/eelgrass habitat were September and November (H). Juvenile surf smelt were generally seen April through September (June peak) in various habitats except the rocky/kelp bed type (H). Larval surf smelt were seen in nearly all habitats from January through June (peaks seen in January and March) (H).

In the Grays Harbor study (G), surf smelt were taken only in summer at Whitcomb Flats and the outer harbor, indicating the sampling was on the edge of a larger population of this species, probably located along the coast outside the harbor.

In Willapa Bay surf smelt spawn on beaches around Tokeland and avoid beaches of heavy surf action and thus seem to be restricted to protected bays such as Willapa (F). They are reported to inhabit the plankton rich tidal flats of the Bay (E). Abundances are not known (E).

The Columbia River estuary would not be expected to have this species of smelt, as marine areas provide for its full life cycle unlike the longfin smelt (F-76) which ascends rivers to spawn.

HABITAT REQUIREMENTS - The habitat requirements of surf smelt that we know are the spawning beach requirements which are quite specific. Little is apparently known about their other life history habitat requirements.

Spawning occurs at high tide on sand beaches where surf action covers and aerates the eggs (533) but areas of excessive surf action or drying of the eggs are avoided (166). The areas include sheltered bays and coves or in the mouths of tidal streams (J). Fine gravel beaches are also used (780). These smelt tend to use shaded spawning beaches in summer and unshaded areas in winter, using a particular beach for two to four months (980).

The ongoing North Sound studies (H), indicate that adult, juvenile, and larval utilize almost all of the five habitat types (exception was juveniles were not taken in the rocky/kelp bed type). This study would indicate the surf smelt is quite adaptable to many habitat types as all life stages except during the spawning act itself.

Surf smelt utilize the open water habitat type throughout life except as an egg and young larvae attached or very near the bottom. A bottom association with bottom types is not very specific.

CRITICAL HABITAT AREAS - The surf smelt is widely distributed but uses specific areas to spawn. These spawning areas are widely scattered in inside waters.

The four major surf smelt spawning areas in Puget Sound lie in southern Hood Canal, southernmost Puget Sound, Liberty Bay and northern Saratoga Passage.

Small spawning stocks utilize upper Case Inlet, Quartermaster Harbor, Sinclair Inlet, Dyes Inlet, Kilisut Harbor, Dungeness Harbor, N. Skagit Bay, Fidalgo Bay and Port Susan.

All these areas are designated as F-75 on the attached maps.

DATA GAPS - A catch summary for surf smelt in the western Strait of Juan de Fuca and coast should be completed.

Life history information is needed for more areas as is being completed in North Sound using beach seines and two nets. The pattern in North Sound is one of non-specific use of habitat types as larvae, juveniles, and adults. This should be checked in other areas using similar methods.

REFERENCES - C, D, E, F, G, H, I, J, K, V, X, 166, 207, 211, 218, 287, 396, 444, 490, 533, 725, 780, 920, 975, 980

FACT SHEET

F-76 LONGFIN SMELT

Spirinchus thaleichthys

LIFE HISTORY - The longfin smelt is anadramous but is also land-locked in some areas (Lakes Washington and Union) (166). Little is known of their saltwater life history (166). The life span is two years (261), three years (166). Maturity is reached in two years (166). Fecundity in Lake Washington ranged from 9,621 to 23,634 eggs/female (166). Mature adults ascend rivers to spawn. Spawning in streams near the sea is reported from October to December in British Columbia (166). Lake Washington spawning peaks in even numbered years and occurs in February to April. In North Sound, juveniles were encountered from April to August (H), indicating a probable spawning period from February to April.

The saltwater life history of anadromous forms was not described in the information reviewed.

Migrations were not reported, but longfin smelt would be expected to move extensively in the open water habitat. They also ascend rivers to spawn.

Foods of longfin smelt include small crustaceans (euphausiids, copepods, cumaceans) (211, 372, 373, 444). Grays Harbor longfin smelt ate mysid shrimp and *Corophium sp.* (G).

This smelt grows to six inches (166) and is probably incidental to commercial and sport fishing in Washington.

WASHINGTON DISTRIBUTION - Longfin smelt are not reported in the numbers seen for surf smelt (F-75) in inside Washington waters (C). Longfin smelt are reported in "50 or more" reports in only one area - Everett, while three areas, Admiralty, Hood Canal, and Colvos Passage, have no reports (C). The remaining eight areas have either "10 to 49, or fewer than 10" reports (C). The geographical summary of these reports (D) shows the bulk of the inside water reports from Everett and north to Bellingham Bay with many reports in East Sound of Orcas Island. No comparable record summary exists for the western Strait of Juan de Fuca and coast.

In the North Sound beam trawl survey, longfin smelt were not reported (I). In an ongoing North Sound survey (H), longfin smelt were reported as common occurrence in the mud/eelgrass, gravel, and rocky/kelp bed habitats and an uncommon occurrence in the sand/eelgrass and cobble habitats (as shown by tow net). Adult longfin smelt were seen in most of these habitats in June to September and December, with a peak noted in the cobble habitat in July (H). Juvenile longfin smelt were seen in most habitats (except gravel) in April to June and in August (H).

In Grays Harbor, this smelt was abundant in all the deeper (otter-trawled) water of the inner Harbor and both gravid and spawned-out adults were taken in the upper Harbor during late fall and winter (G). Most of the spring and early summer smelt taken were thought to be this species (G). Longfin smelt are reported in the deeper waters of Willapa Bay (E) and spawn in the tributaries of the Bay between October and December (F). They are dependent on the estuary for survival (F).

The Columbia River estuary to Puget Island is expected to receive great numbers of this smelt both for spawning in small stream tributaries at the mouth of the river and to tributary streams above Puget Island. Numbers were not located in the information reviewed.

HABITAT REQUIREMENTS - Little is known about the marine and estuarine life history (166) and habitat requirements of this species of smelt. They do need suitable rivers for winter spawning. An example is the Chehalis River and probably other streams that enter Grays Harbor (G). The North Sound study (H) would indicate the marine and estuarine life of longfin smelt while near shore in the open water habitat has no specific bottom association as all habitat types are used. This species may be more pelagic and may only be over these areas and not really associated with them.

They are found to 75 fathoms, mostly in winter in deeper waters (166). Bottom associations in these offshore areas were not described. The longfin smelt is expected to be a schooling surface/midwater/deeper water pelagic species as a late juvenile and adult before ascending streams to spawn.

CRITICAL HABITAT AREAS - The marine and estuarine life history of longfin smelt is little understood. This smelt is assumed pelagic with a loose bottom association - at least while near shore. Many bottom habitat types were occupied in one North Sound study (H).

Too little information exists about this species' life history and general habitat requirements in the marine and estuarine area to define any areas as critical.

DATA GAPS - A catch record summary should be completed for longfin smelt in the western Strait of Juan de Fuca and coast. With this background, an exploratory survey could begin.

The marine and estuarine life history must be studied in representative areas of North Sound (under way), South Sound and coast, to look at distribution and abundance with time, habitats used, and foods eaten. Beach seines on beaches and tow nets and otter trawls in offshore areas would be workable sampling tools.

REFERENCES - C, D, E, F, G, H, J, 166, 211, 261, 372, 373, 444.

FACT SHEET

F-77 EULACHON

Thaleichthys pacificus

LIFE HISTORY - The eulachon, like the longfin smelt (F-76), is anadromous, utilizing mainly the larger and intermediate sized rivers (166). This species is also known as Columbia River smelt (J). Life span may be in excess of four years (166). Maturity is reached at three years (442). Fecundity ranges from 17,300 to 39,000 eggs/female, depending on size (166). This smelt is sexually dimorphic, especially at breeding time (514). Most eulachon die after spawning (442). Some smelt do survive (166), possibly the 20 to 30 percent seen as four year olds (J). Rivers are ascended and spawning and hatching occurs in March to May (21). Adhesive eggs are laid (166). Eggs hatch in 30 to 40 days to produce larvae which rapidly drift downstream (Fraser River) to the sea where they are located in the echo-scattering layer of the sea or remain (and grow slower) in the Strait of Georgia and approaches to the River (166).

The marine and estuarine life history was not discussed for Washington in any detail in the references reviewed. If the Fraser River pattern holds, a nearer shore and offshore pattern of development may also exist for Washington eulachon.

Migrations could be extensive for offshore swept eulachon (as larvae) who may return to streams of origin. Migration is not discussed in the information reviewed.

Foods of eulachon larvae and post-larvae include phytoplankton, copepod eggs, copepods, mysids, ostracods, barnacle larvae, cladocera, worm larvae, and larvae of other eulachon, while juveniles and adults eat euphausiids and copepods (166).

Eulachon grow to about 9 inches (199) and are both important as commercial and sport fish in Washington.

<u>WASHINGTON DISTRIBUTION</u> - In inside waters, eulachon are third-ranked in total reports behind the more numerous surf smelt (F-75) and longfin smelt (F-76) based upon the record summary (C). This summary (C) has only one area San Juan Islands with "10 to 49" reports. Six areas have no reports and the remaining five areas have "fewer than 10" reports (C). In the geographical summary of these inside water catches (D), catches are scattered with some in the deeper waters of the eastern Strait of Juan de Fuca. Those areas with reports are scattered except for some reports in East Sound, (Orcas Island) (D). A total of 43 fish (as one or two fish reports) exist in this summary (D). No comparable catch summary exists for the western Strait of Juan de Fuca and coast.

In the North Sound beam trawl study, eulachon were not reported (I). In an ongoing North Sound study (H), eulachon were not taken.

In the Grays Harbor study, eulachon were not taken but the authors speculate they enter the Harbor to a limited extent (G). Eulachon were not mentioned in Willapa Bay (E, F).

The lower Columbia River is the main transport area for eulachon in Washington with over one million pounds landed annually since commercial statistics were available (J). The fish are taken below Vancouver in the main river and in the Grays, Cowlitz, Kalamia, Lewis, and Sandy Rivers (the main smelt producing tributaries) (J). The Grays River is the only tributary in this study area - up to Puget Island. The Nooksack River also supports runs of eulachon (J).

HABITAT REQUIREMENTS - Eulachon habitat requirements, like their life history in marine and estuarine waters, is not greatly understood. They utilize the open water habitat as surface/underwater fish, possibly following the diel movement of planktonic foods. They would be expected to be bottom-associated as larvae entering the sea and as adults returning to rivers to spawn. This may be a brief and general relationship as no eulachon were taken in a North Sound study (H) that captured other smelt species. Eulachon may move right through these near shore waters going to and coming from the open water habitat.

CRITICAL HABITAT AREAS - Little is known of eulachon life history and habitat requirements in marine and estuarine waters. On the basis of sheer numbers, the lower Columbia River has the bulk of eulachon but most of the fish apparently move above the study area to spawn, the exception being Grays River. In this study area Grays Bay and Bellingham Bay may be critical if larvae remain for any time in these areas or if adults hold in these areas before entering the Grays River or Nooksack River to spawn.

No areas can be defined on the limited information available.

DATA GAPS - The catch records of eulachon in the western Strait of Juan de Fuca and coast should be summarized.

Sampling with tow nets and trawls should be made to intercept adults returning to rivers and with fine-meshed nets looking for larval locations at sea. Juveniles and adults should also be sought in open water areas where past catch records have located them.

REFERENCES - C, D, E, F, G, H, I, J, 21, 166, 442, 514.

FACT SHEET

F-78 CAPELIN

Mallotus villosus

LIFE HISTORY - Capelin are a northern smelt species whose southern limit is stated as Bentinick Island (southern end of Vancouver Island) (166), however a record exists for Sequim Bay (D). The life history of capelin is similar to surf smelt (F-75) with spawning at high tide on beaches with fine gravel. Spawning occurs in late September and early October in British Columbia (166). The life span is three to four years (776). Fecundity in southern British Columbia is reported to average 4,600 for small fish and as great as 6,670 (166). Where fish are larger (farther north) fecundity is much greater, 56,000 to 60,000 eggs/female (166). Although another report (259) indicates three years, a high spawning mortality is reported (259).

The eggs are adhesive, usually attached to coarse sand grains, and are buried by wave action as deep as six inches (776). They hatch in two to three weeks (166). The life history past this stage was not described. They would be assumed to take up a pelagic existence although they may remain near shore. Migrations of capelin were not specifically reported but probably do occur to some extent between the larval stage and the grown spawning adult stage.

Foods of capelin include euphausiids, copepods, marine worms, and small fish (166, 259, 444).

Capelin grow to about five inches (166) and are probably not important commercially because of limited numbers in Washington.

WASHINGTON DISTRIBUTION - Capelin are reported only in one area of Washington - Sequim Bay in one study (C), where "50 +" are reported (D). No comparable summary exists for the western Straits and coast. The ongoing North Sound study located a few capelin in the cobble habitat in May (H). A few capelin are possibly scattered in the North Sound, Strait of Juan de Fuca area. None are reported in coastal bays (G, E, F).

HABITAT REQUIREMENTS - Capelin utilize cobble habitats in North Sound based upon one report (H). The spawning habitat is on beaches of fine gravel or coarse sand and this is known in only one Washington area - the west side of Sequim Bay (D).

The capelin is reported to migrate in schools in the open water habitat with mature males congregated near the shoreline while mature females are found 90 to 150 feet offshore (259).

The capelin is thought to use the open water habitat with possibly a cobble bottom association. Beaches of fine gravel and coarse sand are utilized in spawning. Little is known of their general habitat use when not spawning; but they presumably use the open water habitat with little bottom association for the remainder of their lives.

CRITICAL HABITAT AREAS - The capelin is a complicated species to evaluate for critical habitat areas, simply because of the small numbers apparently in Washington and the small amount of information on their general habitat requirements. However, only one spawning area (Sequim Bay) is known in the State and this is labeled a critical area. Further work may reveal this spawning area is not as unique as it now appears, which would require the reconsideration of this critical area designation. This area is coded F-78 on attached maps.

DATA GAPS - Catch summaries for the western Strait of Juan de Fuca and coast should be completed. Capelin are not assumed as far south as the outer coast.

A first step would be the survey of bays with appropriate beaches in September and October in areas in the Sequim Bay vicinity to see if other spawning areas exist. If located, surveys with plankton nets (for larvae) and tow nets and beach seines should proceed to learn more about their marine distribution, away from the spawning beaches.

REFERENCES - C, D, E, F,G, H, 166, 259, 444, 776.

FACT SHEET

F-79 WHITE SEABASS

Cynoscion nobilis

LIFE HISTORY - The white seabass are not common residents of Washington waters and are rare, usually appearing in late summer or fall when our water temperatures are warmest (K), and only in exceptionally warm years. The white seabass ranges from the Gulf of California to southeastern Alaska but uncommon north of San Francisco (166).

Little life history exists for this species in the literature review (A). No source indicates the species spawns in the Pacific Northwest. In California they spawn from March to August near kelp beds (166). In California half of the females are mature at 28 inches and half of the males at 24 inches (166). All are mature by 29.5 inches (166).

Migrations were not described, but would be assumed to be extensive to allow near shore movements from California areas to British Columbia and Alaska waters. White seabass are fisheaters, taking anchovies, pilchards, herring, and smelt, as well as squid and crayfish (166).

White seabass grow to four feet (166) and are probably incidental commercial and sport species when they are present in sufficient numbers in Washington waters.

WASHINGTON DISTRIBUTION - Few white seabass are reported in inside waters. Only two single specimens have been taken (one in Puget Sound in 1919, and one between Camano Island and the mainland in 1956)(D). No comparable record exists for the western Strait of Juan de Fuca and coast. The only other reports located were for fish hooked off Ilwaco and Westport (K). They are observed in the Strait of Juan de Fuca and on the west coast of Vancouver Island (166). This species was not taken in North Sound (H, I) or coastal bay studies (G, E, F).

HABITAT REQUIREMENTS - Little is reported except that they spawn near kelp beds (166). The family *Sciaenidae* is characterized by fishes of shallow inshore waters (166) and occupy the open water habitat with some bottom or vegetation association.

CRITICAL HABITAT AREAS - The general habitat cannot be described, so critical areas are not definable. This species requires the rare warmer than average late summer and fall water temperatures last seen in Washington in 1957-1959. Because of the apparent sporadic nature of white seabass in Washington, a question exists as to whether this species is in fact "significant" in Washington waters.

DATA GAPS - The white seabass does not seem to occur consistently in numbers justifying research directed at this species.

REFERENCES - A, D, E, F, G, H, I, K, 166.

FACT SHEET

F-80 PACIFIC SAND LANCE

Ammodytes hexapterus

LIFE HISTORY - The Pacific sand lance is a small schooling fish that is quite important as a food fish of many commercially important species. This species has a varied life, sometimes offshore, sometimes in large schools in tidal currents in channels, possibly sometimes in deep water, and at times buried more or less completely in beach sand (166). Life span is three to seven years (259). Age of maturity and fecundity were not located. Spawning is at 14 to 55 fms with adhesive eggs released (259) presumably onto or into sand bottom. The spawning is believed during winter (780) and is reported on the open coast from November to February in areas of strong current on coarse sand (259). Burrowing in sand or gravelly bottoms may be associated with spawning (J). Planktonic larvae are reported seen between December to May depending on the area (A), and in abundance in early spring (J). Larvae in North Sound were seen in April - June, and juveniles were seen May - September (H). The adult forum is reached at about 2 inches by early summer after metamorphosis (J).

Life history was not described in any more detail in the sources reviewed.

Migrations are not reported except for a movement into sand at night and feeding off the bottom during the day (259). As a schooling fish, that appears in many habitats, quite extensive migrations may be made. Feeding is during the day (259). Larvae eat phytoplankton, copepod nauplii, juveniles eat copepods, amphipods, and fish larvae, and adults eat copepods, fish larvae annelids, and chaetognaths (259). Pacific sand lance grow to eight inches (166) and are usually not in sufficient number to warrant commercial fishing (J).

WASHINGTON DISTRIBUTION - Pacific sand lance apparently have declined in Puget Sound from past period when they were caught for bait while in North Sound, more seem to be apparent than previously reported (Al Lasater, WDF, personal communication). In inside Washington waters, Pacific sand lance were reported in "50 or more" reports in three areas - San Juan Islands, Bellingham area, and Seattle area and were not reported in three areas - Georgia Strait, Hood Canal and Colvos Passage (C). Hood Canal later had 12 + reports of sand lance (D). The geographical record of this catch reports (D), show concentrations reported for Sucia Island (south side), Bellingham Bay, Friday Harbor and West Point to Shilshole Bay (Seattle area). Few or no reports exist in most areas south of Seattle in Puget Sound and south of Black Point in Hood Canal while remaining areas have scattered records (D). No comparable summary exists for the western Strait of Juan de Fuca and coast.

The North Sound beam trawl survey (I) did not report this pelagic species as might be expected. In the ongoing North Sound study (H), Pacific sand lance were reported, a common occurrence in all five habitats (as shown by tow net) and beach seine showed generally lesser abundance with none in mud/eelgrass. Adult sand lance were seen in sand/eelgrass in most months of the (but not in all months) with peak abundance in May, July, and August (H). The other four habitats were sporadically reported through the year (H). Juvenile sand lance were seen in all five habitats in June and July with peak abundance in the rocky/kelp bed habitat in this period (H). Juveniles were seen in two or three habitats in May and August also (H). Larval sand lance were seen in all five habitats in April and

May with peaks in abundance in mud/eelgrass and sand/eelgrass in April (H). Larval fish were also seen in the gravel habitat in June (H).

In the Grays Harbor Study (G) sand lance were taken only in the summer and were common only at Whitcomb Flats. This species was reported only from the inner harbor (218). Sand lance were not reported in Willapa Bay, (E, F,) but may be seen in Grays Harbor in summer in outer parts of Bay.

Pacific sand lance are reported around river outlets (166) so may be in the vicinity of the lower Columbia River estuary.

HABITAT REQUIREMENTS - The varied life of Pacific sand lance appears to place them in many habitats - deep water, shallow water, to buried in sand/gravel beaches. The sand lance utilizes the open water habitat as a pelagic larvae, and presumably becomes more bottom associated with time until eggs are deposited and sand burial takes place. However, adults are also seen pelagic so there is not a simple pattern of increasing bottom dependence with age. The multiple habitats in which sand lance were taken in North Sound (H) tends to indicate this species utilizes the pelagic waters over many habitat types not being that specific as to bottom type. The wide range of habitats is also described in British Columbia (166). The exception seems to be at or near the spawning period where this species buries itself into sand and light gravel beaches from the high intertidal to shallow subtidal.

Burrowing may also be a night time escape mechanism and regularly occur for sand lance in shallow waters. Pelagic sand lance are reported above strong thermocline areas where they exist (259).

CRITICAL HABITAT AREAS - Pacific sand lance appear to be more pelagic open water fish that utilize a wide variety of bottom habitat types while in shallow waters. The exception is the use of sand/light gravel beaches for burrowing and spawning related activity. This study did not discover specific data to beaches used consistently by great number of Pacific sand/lance. This beach use would seem to be the general area of potential critical habitat areas for this species as burrowing for protection (possibly) and for spawning, occurs on these beaches.

As more information becomes available, some beach areas may stand out from the others as important to sand lance. No areas are designated for Pacific sand lance.

DATA GAPS - Pacific sand lance catch reports should be summarized for the western Strait of Juan de Fuca and coast. Areas of past concentrations should be resampled quarterly by methods utilized in the North Sound Study (H). In this manner, the various life stage temporal and spacial distribution can be learned about this species habitat requirements in Washington.

SCUBA methods might be useful in areas with allowable visibility to seek more information on the night and spawning burial behaviors of the sand lance. Comparable methods should be test fished over time in a single area to learn more about this species presence and abundance within a shorter time frame (24 hours).

REFERENCES - A, C, D, E, F, G, H, I, J, 166, 218, 259, 780.

FACT SHEET

F-81 SPINY DOGFISH

Squalus acanthias

LIFE HISTORY - The spiny dogfish is the most common of all sharks in Washington waters being particularly numerous in Puget Sound (J). Life span of dogfish are variously reported- 15-30 years (493), 29 years (479), more than 30 years (369) and up to 40 years (166). Females (50 percent) reach maturity at 93.5 cm, males (50 percent) at 72 cm (166). Females are internally fertilized and unlike the skates (F-40, F-41) that release fertilized eggs in cases, the dogfish gives birth to live young (166). Gestation periods are reported from 16 to 26 months (J), two years (780), and 23 to 24 months (166). Number of young pups produced vary with the females size. An average number is 8 (369) or 10 (493), with a range of 2 to 20 young/female (166). Spawning occurs "offshore" and offshore nursery areas exist (493). Dogfish school by age and sex (393). Populations exist that seem separate from indigenous groups in Puget Sound to migratory groups in outside waters with little mixing via the Strait of Juan de Fuca (166).

The movement and migrations of dogfish presents a confusing pattern (166). Tagged fish in Puget Sound and the Strait of Georgia were mostly recovered (75%) from the area of release (166). Local movements also take place (166). Indigenous inshore populations and offshore migrating populations are suggested for Washington (166). Offshore migrations can be quite long - Willapa Bay to Honshu Island, Japan (4000 miles) in 7 years (166). The migration coastal populations is to move north in the summer and south in the winter (479).

Foods of dogfish reflect the opportunistic nature of this species with variation geographically, seasonally, and with depth (166). Young often feed on plankton (166). Foods eaten on the open coast and Puget Sound were as follows (393):

	Fall/Winter	Spring/Summer
Open Coast	Octopus, other fish	Euphausiids, shrimp
Puget Sound	Sculpins, octopus	Euphausiids, shrimp

One survey found 31 fish species (including, herring, hake, sand lance and smelt) and 13 varieties of invertebrates eaten (166). Dogfish are known to concentrate in schools or packs at river mouths (British Columbia) to feed on eulachon and capelin (166).

The spiny dogfish grow to lengths of four to five feet (166) and are both a minor commercial and sport fish in Washington.

<u>WASHINGTON DISTRIBUTION</u> - Spiny dogfish appear numerous in all state waters with the possible exception of the lower Columbia River (to Puget Island). They would be expected at the mouth of the Columbia River.

In inside waters of Washington, the dogfish is reported in "50 or more" reports in all 12 areas (C). In the geographical record of these reports (D), dogfish are all over these waters in no apparent patterns, except that many areas have scattered reports. No comperable record exists for the western Strait of Juan de Fuca and coast. The main populations are said to be in Puget Sound and the Straits of Georgia (479).

The North Sound beam trawl survey (I) did not report this species. The ongoing North Sound study (H) found the dogfish a common occurrence in the mud/eelgrass sand/eelgrass and gravel habitats (as shown by tow net) and in the rocky/kelp bed (as shown by trammel net). The dogfish was an uncommon occurrence in the cobble habitat (as shown by beach seine) and in the rocky kelp bed (as shown both by tow net and SCUBA). The dogfish was taken in most of the five habitats in July to September, in the rocky/kelp bed habitat also in December and March, in the sand/eel grass habitat also in May and in the mud/eelgrass habitat also in June (H).

In the Grays Harbor study (G), this dogfish was taken in summer when they were common in the North Channel and present at Whitcomb Flats and the outer Harbor. This source (G) indicates that sampling methods may have missed individuals of this species and that dogfish may be more common than seen. Dogfish were not reported for Willapa Bay (E, F) but would be presumed to be there. No report was located of dogfish in the mouth of the Columbia River, but if like the Fraser River, dogfish may school and feed on species moving into the river like the eulachon (F-77).

HABITAT REQUIREMENTS - Spiny dogfish are very abundant in sand and mud bottom areas (K). They use the open water habitat but appear to be strongly bottom oriented most of their lives at least when nearshore. Offshore schools may be more pelagic. This dogfish has been located from the surface to 400 fms (166). They probably are quite adaptable moving with available food species from bottom areas to the surface when offshore. While nearshore dogfish appear to be opportunistic using a wide variety of bottom habitats from mud to rocky/kelp bed areas.

CRITICAL HABITAT AREAS - The opportunistic activities of dogfish seem to cross all habitat boundaries and not be specific to certain areas. The species is widely distributed in Washington waters and consistent concentration areas were not described. Offshore spawning and nursery areas are discussed (493) but no specific areas were noted in the literature survey (A). At present, no critical areas are apparent in the information reviewed.

DATA GAPS - See big skate (F-40).

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